"ASSESSMENT OF OUTCOME OF PERCUTANEOUS DRAINAGE IN TREATMENT OF LIVER ABSCESS"

Dissertation submitted

To

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DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation titled **"ASSESSMENT OF OUTCOME OF PERCUTANEOUS DRAINAGE IN TREATMENT OF LIVER ABSCESS''** is a bonafide and genuine research work carried out by me under the guidance of **Prof. R.VASUKI, M.S.,** Department of General Surgery, Kilpauk Medical College, Chennai-10. This dissertation is submitted to **THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY, CHENNAI** in partial fulfillment of the degree of M.S. General Surgery examination to be held in **April 2017**.

Date:

Place: **Dr.K.MADAN**

CERTIFICATE

This is to certify that this dissertation is the bonafide work of

Dr.K.MADAN

On

"ASSESSMENT OF OUTCOME OF PERCUTANEOUS DRAINAGE IN TREATMENT OF LIVER ABSCESS"

During his course in M.S. General Surgery from JANUARY 2016 to September 2016 at Government Kilpauk Medical College, Chennai-10.

Prof.R.KANNAN, M.S.,
Professor and Head of the Department,
Department of General Surgery,
Govt. Kilpauk Medical College,
Chennai – 10.

Prof.R.VASUKI, M.S
Professor of the General Surgery,
Department of General Surgery,
Govt Kilpauk Medical College,
Chennai – 10.

Prof.R.NARAYANA BABU, M.D, DCH.
DEAN Govt. Kilpauk Medical College,
Chennai-10

CERTIFICATE BY THE GUIDE

This is to certify that the dissertation titled **"ASSESSMENT OF OUTCOME OF PERCUTANEOUS DRAINAGE IN TREATMENT OF LIVER ABSCESS"** is a bonafide research work done by **Dr.K.MADAN**, post graduate in M.S. General Surgery, Kilpauk Medical College, Chennai-10 under my direct guidance and supervision in my satisfaction, in partial fulfillment of the requirements for the degree of **M.S. General Surgery**.

Date:

Place:

Prof.R.VASUKI, M.S.,
Professor of General Surgery,
Kilpauk Medical College,
Chennai-10

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INTRODUCTION

Abscess is collection of pus in the body and abscess can occur anywhere in the body. A collection of suppurative cavity in the liver resulting from the invasion, infection and multiplication of microorganisms, entering either directly as in case of amoebic liver abscess or through the blood vessels or by the way of the biliary ductal system as in case of pyogenic hepatic abscess.

Liver abscesses are most commonly due to amoebic(in tropics), pyogenic or mixed infections. Less commonly these may be fungal in origin. Liver abscess due to amoebic infection occurs more commonly in men between 20 and 50 years of age, but can occur at any age but the disease is fatal in extremes of age. About 60- 70% are solitary and mainly located in the right lobe of the liver, as a result of the flow of right portal tract blood to right lobe but amoebic infection can also affect left lobe and multiple abscess are not uncommon. But when multiple abscesses are present, pyogenic or mixed is the most probable type.

Patients usually present with non-specfic symptoms initially. As the disease increases in severity there is appearance of fever, right hypo-chondrial (upper quadrant of the abdomen) pain which may or may not be referred to the right shoulder.

Since the disease presents with non-specific clinical feature initially, most patients are diagnosed in late stages only.

Though the incidence of hepatic abscess is rare in the developed Countries, it is still a major health problem associated with morbidity and even mortality if not treated properly in tropical countries. But even in developed countries there is recent surge in incidence due to increase in immunosuppression in patients due to various reasons.

But, advances in sonography and computerized tomography scanning and interventional radiology along with improvements in intensive care, administration of appropriate antibiotic therapy led to greater success in management of patients with liver abscess, thus improving the patient outcome.

The management of hepatic abscess by percutaneous drainage has been an important advancement in the treatment of pyogenic liver abscesses. There are two main methods in Percutaneous treatment. They are intermittent needle aspiration and continuous catheter drainage.

Minimal assess intervention through this method is now a standard management for liver abscesses. It has become first line method and also used to optimize patients requiring surgical exploration which now has very limited indications in patients presenting with peritonitis and failed percutaneous technique.

Intermittent needle aspiration is less expensive but has lower success rate than drainage method and it also require repeated aspiration. It has an advantage though that multiple small abscesses can be aspirated

through different tracts in the same sitting. Important drawback of aspiration is that repeated needle aspirations may be required in a single patient over a short period of time which is painful and unpleasant for the patients and hence may not be acceptable and larger cavities often reaccumulate.

To avoid these unpleasant pain associated with needle aspiration, percutaneous catheter drainage can be used first tool in the management of hepatic abscesses. The advantage of catheter drainage is that it provides a route for continuous flow of pus and hence the problems of incomplete and repeated evacuations are not encountered.

AIM OF THE STUDY

1. To evaluate need and the outcome of percutaneous drainage in treatment of liver abscess.

2. Assess if there is an increased success rate and reduced the time required to achieve clinical relief in patients with liver abscess.

3. To determine that whether percutaneous catheter drainage is more effective in management of large liver abscess.

JUSTIFICATION FOR CONDUCTING THE STUDY

1. Percutaneous management is becoming more commonly used due to wider availability of facilities.

2. The treatment of liver abscess ranges from conservative treatment to surgical intervention like drainage of pus. Surgical drainage has been the traditional mode of treatment .Newer treatment option in the form of catheter drainage under antibiotic cover has shown promising outcome. Its success rate goes up to 95 % according to different studies

3. To assess the rate of decrease in size of liver abscess by percutaneous method.

4. No proper studies to assess the role of percutaneous drainage in liver abscess when compared to other forms of treatment in south india.

REVIEW OF LITERATURE

The occurrence of pyogenic liver abscess (PLA) is around 1.1 to 2.3 cases per 100,000 population every year. PLA occurs mainly in immunosuppressed and diabetic.

Patients with Amoebic liver abscess is more often found in endemic countries like India.

REVIEWS SUPPORTING AGE AS AN INDICATOR FOR LIVER ABSCESS:-

Alvarez JA et al[3] studied comparison of older and younger patients with pyogenic liver abscesses and found that "Elderly patients with pyogenic liver abscess have some subtle differences in clinical and laboratory presentation, but these do not appear to delay diagnosis. Active management is tolerated well, with a lower morbidity rate than in younger patients and no difference in the mortality rate".

REVIEWS SUPPORTING ROLE OF DISEASES WHICH LEAD FORMATION OF LIVER ABSCESS BY MICROORGANISM:-

Cerwenka H et al[4] found that "Microbiological testing provides important information for treatment monitoring and modification. Complementary assessment of risk factors for a complicated course is crucial for timely identification of patients requiring additional treatment".

Chen SC et al[5] studied about E.coli liver abscess “The predominant causes of E. coli liver abscess were biliary diseases. This report also highlights that E. coli liver abscess has a relatively high mortality rate, which is associated with underlying malignancy, multiple abscesses and profound hypoalbuminemia.”

Li J et al[6] studied about early diagnosis and therapeutic choice of Klebsiella pneumonia liver abscess concluded that “the strong association with diabetes, milder clinical symptoms, and gas-forming nature in CT images makes early pathogenic diagnosis of KLA possible. Comparatively, ultrasonography-guided percutaneous liver aspiration with retained catheter may be the most rational intervention modality of KLA”.

Ferreira JP et al[7] did a retrospective analysis of Methicilin resistant Staphylococcus aureus and liver abscess and found that “The majority of pyogenic liver abscesses are polymicrobial, with enteric and anaerobic bacteria being the most common.

The most common pathogen isolated was Escherichia coli. Staphylococcus aureus are found in around 7% of the liver abscesses. This infection usually results from hematogenous dissemination of bacteria that's infecting some other organ. Percutaneous drainage combined with antibiotic therapy was the most frequent treatment used. All MRSA isolated were susceptible to trimethoprim - sulfamethoxazole

and vancomycin. The underlying conditions most frequently found were biliary diseases, followed by recent abdominal surgery, which in turn was the most frequent predisponent condition in MRSA liver abscesses".

Cosme A et al[8] conducted a comparative clinical study in a series of 58 patients for pyogenic versus amoebic liver abscesses and found that " In our series, the clinical parameters suggesting pyogenic origin were: age 50 or older, male gender, diabetes, moderately elevated bilirubin and transaminases. In amoebic cases the associated features were being aged 45 or younger, diarrhoea, and presence of a single abscess in the right lobe.

Parasitism by E. histolytica must be considered in the differential diagnosis of liver abscesses, even with no epidemiological clinical history of travel and/or immigration".

Liew KV et al[9] retroseptively reviewed patients and found that "Most patients presented with non-specific clinical and biochemical features.

A raised alkaline phosphatase level was the most common biochemical abnormality found in about two-thirds of patients.

Klebsiella pneumoniae was the most common etiological agent detected in cultures of blood and abscess aspirates. All patients were treated with intravenous antibiotics. Twenty-two (30%) needed percutaneous catheter drainage and five patients (7%) required surgical

management. Prolonged hospitalisation was associated with advanced age, degree of loculation within the abscess, concomitant diabetes mellitus and Klebsiella septicaemia" and concluded that "Pyogenic liver abscesses require a high index of suspicion for early diagnosis. When appropriate therapy in the form of antibiotics in combination with percutaenous drainage or surgery is administered, mortality is very low.

However, significant morbidity is still a problem, particularly in the elderly, diabetic patient".

Naveed S et al[10] researched about liver abscess in tropics " the diagnostic criteria for the various types of abscesses were as follows: Amoebic abscess: demonstration of Entamoeba histolytica trophozoites in aspirated pus. Pyogenic abscess: positive cultures of blood or aspirated pus . The majority of patients in our study had amoebic liver abscesses (73.33%). Escherichia coli and Klebsiella were the most common organisms culturedfrom the pyogenic abscesses. The majority of patients with amoebic liver abscesses were treated with drug therapy alone, whereas all pyogenic liver abscesses required some form of drainage".

REVIEWS SUPPORTING NEED FOR DRAINAGE IN LIVER ABSCESS:-

Khan R et al[11] predicted the factors for liver abscess drainage "Patients with advanced age, abscess size > 5 cm, both lobes of the liver

involvement and duration of symptoms > 7 d were likely to undergo aspiration of the liver abscess, regardless of etiology".

REVIEWS SUPPORTING EFFECTIVENESS OF DRAINAGE IN LIVER ABSCESS COMPARED TO OTHER METHODS OF TREATMENT:-

Rajak CL et al[12] said that "percutaneous catheter drainage is more effective than needle aspiration in the treatment of liver abscesses."

Zerem E et al[13] suggested "PCD is more effective than percutaneous needle aspiration in the management of liver abscess. Percutaneous needle aspiration can be used as a valid alternative for simple abscesses 50 mm in diameter or smaller."

Singh S et al[14] stated that " Percutaneous catheter drainage is a better modality as compared to percutaneous needle aspiration especially in larger abscesses which are partially liquefied or with thick pus."

Jha AK et al[15] concluded that "percutaneous catheter drainage is more effective in management of large amoebic liver abscess than needle aspiration."

Jha AK et al[15] also said that "The mean hospital stay of patients treated with needle aspiration was more than those treated with catheter drainage.

The mean time in days taken for 50% decrease in the size of abscess cavity was significantly greater in group treated with needle aspiration than in those treated with catheter drainage (9 days versus 4 days)."

Singh O et al[16] concluded that "PCD is a better treatment option than PNA for the management of large liver abscesses of size >10 cm, in terms of duration to attain clinical relief and duration for which parenteral antibiotics are needed"

Cai YL et al[17] observed that "Both PNA and PCD are safe methods of draining liver abscesses. However, PCD is more effective than PNA because it facilitates a higher success rate, reduces the time required to achieve clinical relief and supports a 50% reduction in abscess cavity size."

Ferraioli G et al [18] did observation over a 21-year period in 148 patients to state that "Percutaneous and surgical treatment of pyogenic liver abscesses are both effective, nevertheless percutaneous drainage carries lower morbidity and is cheaper".

Bansal A et al[19] found that "The success rate was significantly better in catheter drainage group. The patients in pigtail catheter drainage group showed earlier clinical improvement and decrease in abscess cavity volume as compared to those who underwent percutaneous needle aspiration"

REVIEWS AGAINST EFFECTIVENESS OF PERCUTANEOUS DRAINAGE IN LIVER ABSCESS WHEN COMPARED TO OTHER METHODS OF TREATMENT:-

Dulku G et al[20] hypothesis that "both Percutaneous needle aspiration and Percutaneous Catheter Drainage are equally effective in the drainage of liver abscess cannot be rejected. Apart from PA being simpler and safer to perform, the higher incidence of indwelling catheter-associated complications suggests that a trial of PA should always be attempted first".

Tan YM et al[21] study results showed that "for large liver abscesses more than 5 cm, Surgical drainage provides better clinical outcomes than percutaneous drainage in terms of treatment success, number of Secondary procedures, and hospital stay with comparable morbidity and mortality rates. SD should be considered as first-line treatment of large liver abscesses".

Malik AA et al [22] found that "Transperitoneal surgical drainage and antibiotics are the mainstay of treatment. Percutaneous drainage is recommended for high risk patients only".

REVIEWS SUPPORTING EQUAL EFFECTIVENESS OF CATHETER DRAINAGE IN LIVER ABSCESS WHEN COMPARED TO OTHER METHODS OF TREATMENT:-

Yu SC et al[23] this study suggests that "intermittent needle aspiration is probably as effective as continuous catheter drainage for the treatment of pyogenic liver abscess"

REVIEWS SUPPORTING CATHETER DRAINAGE IN LIVER ABSCESS AS FIRST LINE OF TREATMENT:-

Bergert H et al[24] investigated and compared different therapeutic options, i. e. ultrasound-guided percutaneous abscess drainage, CT-guided drainage and open surgical drainage and found better results for the ultrasound-guided interventions to suggest that "ultrasound duplex imaging with percutaneous abscess drainage is a reliable and effective approach for the treatment of pyogenic liver abscess. Based on other studies in the literature and our own results we developed a diagnostic and therapeutic algorithm for the treatment of liver abscesses".

Bednarek M et al[25] said that "Percutaneous sonographically-guided drainage together with antimicrobial therapy constitutes valuable method of choice in the management of liver abscess. The technique has small morbidity and complication ratio allowing avoidance of more invasive surgical interventions."

Italiya HB et al[26] studied 25 patients During a period of 27 months and suggested that "Percutaneous catheter drainage of liver abscesses is successful with a low morbidity and mortality and should be the first line of management in liquefied moderate to large sized liver abscesses"

REVIEWS SUPPORTING INDIVIDULIZATION OF TREATMENT FOR LIVER ABSCESS:-

Mangukiya DO et al[27] said that "Drainage is necessary for large abscesses, equal to or larger than 5 cm in size, to facilitate resolution. While percutaneous drainage is appropriate as first-line surgical treatment in most cases, open surgical drainage is prudent in cases of rupture, multiloculation, associated biliary, or intra-abdominal pathology. Percutaneous drainage may help to optimize clinical condition prior to surgery"

Mangukiya DO et al[27] concluded that "In current good clinical practices, the choice of therapy needs to be individualized according to patient's clinical status and abscess factors. They are complementary in the management of liver abscesses.

Hope WW et al[28] proposed "a treatment algorithm with small abscesses being treated with antibiotics alone; large, uniloculated abscess with percutaneous drainage plus antibiotics; and large, multiloculated abscessed treated with surgical therapy"

Chung YF et al[29] said that "Drainage is necessary for large abscesses, equal to or larger than 5 cm in size, to facilitate resolution. While percutaneous drainage is appropriate as first-line surgical treatment in most cases, open surgical drainage is prudent in cases of rupture, multiloculation, associated biliary or intra-abdominal pathology. Percutaneous drainage may help to optimise clinical condition prior to surgery. Laparoscopic drainage is a feasible surgical option with promising results in the future. Liver resection is reserved for concomitant localised intrahepatic disease and tumour, after control of sepsis. The final verdict on the outcome of percutaneous versus open surgical drainage of pyogenic liver abscesses requires further studies in a controlled trial setting. Nevertheless, in current good clinical practices, the choice of therapy needs to be individualised according to patient's clinical status and abscess factors. They are complementary in the management of liver abscesses".

REVIEWS SUPPORTING EFFECTIVENESS OF DRAINAGE EVEN IN AMOEBIC LIVER ABSCESS:-

Gupta SS et al[30] said that "PCD is a better treatment option than PNA for the management of large (>10 cm diameter) amoebic liver abscess, in terms of duration to attain clinical relief and duration for which parentral antibiotics were needed".

Eastiak MF et al[31] stated that "With a very low morbidity and zero mortality rates, minimum treatment costs and early return to regular life style proved this minimally invasive procedure to be a rational treatment option for amoebic liver abscess in selective cases."

Hanna RM et al32 suggested that" PCD is a most useful adjunct to drug therapy and recommend its routine use in the management of drug-resistant amoebic liver abscesses".

REVIEWS ASSESSING THE OUTCOME OF PERCUTANEOUS CATHETER DRAINAGE:-

Malik SM et al[33] quoted "We in our series of 126 pts of liver abscess conclude that image guided percutaneous pigtail drainage of liver abscess is a safe, effective minimally invasive procedure with negligible morbidity and no mortality. High procedural success rate has almost replaced conventional laparotomy in uncomplicated liver abscess".

REVIEWS SUPPORTING THE EFFECTIVENESS PERCUTANEOUS CATHETER DRAINAGE EVEN IN COMPLEX LIVER ABSCESS CASES:-

Liu CH et al[34] stated "Percutaneous drainage is a safe and effective procedure in the treatment of pyogenic liver abscess, regardless of abscess complexity and/or multiplicity".

Ahmed S et al[35] studied safety and sufficiency Percutaneous drainage for giant pyogenic liver abscess and said that "A giant pyogenic liver abscess is defined as an abscess greater than or equal to 10 cm size based on imaging.

Large size itself is not a contraindication for Percutaneous drainage. PD is safe and sufficient even in GPLA patients".

REVIEWS SUPPOURTING THE EFFICACY OF IMAGING GUIDANCE IN TREATMENT OF LIVER ABSCESS AND TROCAR TECHNIQUE :-

Catalano O et al[36] studied about amoebic liver abscess and said that "US and CT findings, though variable and partially different from those previously reported, may be considered sufficient for diagnostic assessment, especially if in the proper clinical and biohumoral setting. Both drug treatment and percutaneous drainage (to be considered for selected cases) are effective in the treatment of this type of abscess".

Benedetti NJ et al[37] said that "Imaging, and in particular ultrasound, plays a crucial role in following patients from treatment to resolution of disease".

Salzano A et al[38] "Combined US and CT assessment facilitated the diagnosis of amoebiasis and its differentiation from pyogenic abscess and hepatoma. The combination of US-guided drainage and drug treatment provides better results than either treatment alone and quicker

improvement of patient conditions, with fewer extra intestinal complications. Percutaneous drainage should be used in abscesses bigger than 4-5 cm, those with questionable clinical-laboratory findings and finally those failing to respond to drug treatment alone. Positive parasitology of abscess content is related to repeated cavity washings after percutaneous drainage, likely because peripheral layers are much richer in amebae".

Lin AC et al[39] suggested "Location of the abscess in segments 4 and 5 of the liver raised the sensitivity of ultrasound for diagnosis, while location in segment 8 was most associated with delayed diagnosis by ultrasonography. Right costal angle knocking pain was significant for pyogenic liver abscess even if ultrasound was negative. The size and location of the liver abscess and the underlying comorbid diseases may affect the diagnostic sensitivity of ultrasound for pyogenic liver abscess in clinical practice. A high index of suspicion should be maintained in patients with diabetes mellitus, previous biliary tract intervention or gastrointestinal malignancy. Follow-up CT scanning is recommended if right flank knocking pain is present, even if ultrasonography is non-revealing. A diagnostic protocol for liver abscess may be feasible in the future."

W.C. Fan et al[40] summarized that "this study has shown that the trocar method is a simple and safe technique for performing common

image-guided drainage procedures, when performed by experienced personnel"

K C S, Sharma D et al[41] did long-term follow-up of pyogenic liver abscess by ultrasound "Majority of pyogenic liver abscess resolve to normal parenchyma within 18 weeks time. However, some lesions may take longer time to heal even after successful treatment. It should be considered in differential diagnosis of space occupying lesion of the liver in ultrasound and need no therapeutic intervention"

MA Abusedera et al[42] assessed Percutaneous treatment of large pyogenic liver abscess to state that "CD is more efficient than intermittent percutaneous needle aspiration. Intermittent percutaneous needle aspiration is an acceptable alternative in abscesses that are 50 mm or less in longest diameter. Aspiration is not efficient for multi septated liver abscesses. These cases should be reserved for CD. Trocar or Seldinger technique can be used for catheter placement, however Trocar is simpler and less time-consuming than the modified Seldinger technique".

REVIEWS FOR FAILURE OF PERCUTANEOUS TREATMENT:-

Onder A et al[43] said that in cases of Failure of percutaneous treatment "Surgical treatment is the sole option for the patients with PLA who;

(a) can't be treated by percutaneous drainage or had an unsuccessful one, (b) have multiple abscess cavity, (c) are

thought to have perforated abscess, (d) have additional abdominal pathology requiring laparotomy".

REVIEWS FOR ROLE OF SURGERY IN LIVER ABSCESS MANAGEMENT:-

O'Farrell N et al[44] discussed that "Radiological intervention and anti-microbial therapy are the mainstay of treatment, and operative intervention is now rarely required."

Alkofer B et al[45] conducted study on 103 liver abscess patients and stated that "Medical and percutaneous treatment constitute the standard management of liver abscess cases. Surgery remains necessary after failure of the initial treatment but should also be considered as an early intervention for cases presenting with gas-forming abscesses and septic shock and when treatment of the underlying cause is immediately required".

Pang TC et al [46] found that "Pyogenic Liver Abscess is a diagnostic challenge, because the presentation of this condition is non-specific. Intravenous antibiotics and radiological drainage in the first instance allows resolution of most PLAs; However, a small proportion of patients still require surgical drainage".

REVIEW OF FACTORS ASSOCIATED MORTALITY AND ROLE OF PERCUTANEOUS IN DECREASING MORTALITY:-

Ruiz-Hernández JJ et al [47] said that mortality associated pyogenic liver abscess are high "Mortality was associated with age , a previous history of coronary heart disease, absence of fever, development of sepsis and/or septic shock, raise of bilirubin levels, a biliary, or cryptogenetic origin, infection owing to E.coli or to Candida and development of pneumonia. The main risk factor for mortality is the development of sepsis and/or septic shock".

Chan KS et al[48] did retrospective analysis of 107 patients during a 3-year period for Pyogenic liver abscess and observed that "the prompt arrangement of imaging studies may lead to an earlier diagnosis. The aggressive performance of image-guided catheter drainage and the appropriate administration of antibiotics may reduce the mortality rate of PLA".

López-Cano Gómez M et al[49] predicted the mortality "PLA developed in patients with comorbidity, although most were cryptogenic. The majority of PLA were resolved with antibiotic therapy and percutaneous drainage, without surgery. Mortality was 9%, but half the patients had unfavorable outcome, associated with biliary etiology and some laboratory alterations."

Shrestha SK et al[50] conducted a prospective observational study and found that "Liver abscess requires a high degree of suspicion for early diagnosis. When appropriate therapy in the form of antibiotics in combination with percutaneous drainage or surgery is administered the mortality is very low.

However, significant morbidity is still a problem in old debilitated persons with other core morbidities."

REVIEW OF SUPPORTING THE LOCATION OF ABSCESS AND ITS ETIOLOGY AND MODE OF TREATMENT:-

Târcoveanu E et al[51] performed a retrospective study during the last twenty years (1987-2007). "The patients were divided in two groups: group I treated during the period 1997-2007 and group II, 1987-1996. The mean age was 47.49 +/- 2.09 years old (range 18-85) with no difference between the groups. The abscesses were situated into the right lobe in 53 cases (74.6%), into the left lobe in 13 cases (18.3%) and into the both lobes in 5 patients (7%). The etiology was diverse: 25.4% after hepatic hydatid cysts, 12.7% with biliary origin, 22.5% with hematogenous and phlebitis origin and 39.4% with unknown origin (cryptogenetic)". Concluded that "Most of the abscesses are unique and situated in the right lobe of the liver. The imaging techniques, especially ultrasound exam and CT-scan, are essential for the diagnosis and the treatment of liver abscesses".

Jha AK et al[52] did a study and found that “Amoebic liver abscess was the most common (88%) type of liver abscess among the study groups. There was a strong correlation with the occurrence of liver abscesses and addiction to alcohol, history of diabetes mellitus and low socioeconomic status. The most common etiology of pyogenic liver abscess was Escherichia coli. Ultrasonography (USG) of the abdomen was accurate and cost-effective in diagnosis of liver abscesses. Percutaneous catheter drainage was the most effective method of treatment (with a 100% success rate)”.

Rahimian J et al[53] found that “Seventy percent of the abscesses were in the right lobe, and 77% were solitary. Klebsiella pneumoniae was identified in 41% of cases in which a pathogen was Recovered. Fifty-six percent of cases involved treatment with percutaneous drainage”.

Mohan S et al[54] stated that “Patients undergoing catheter drainage showed a more rapid reduction in initial abscess volume, whereas resolution of the abscess cavity took longer with antibiotic therapy alone.”

Pearce NW et al[55] performed a review to document the use of imaging and drainage techniques. Liver abscess Aetiology, morbidity, mortality and duration of hospital stay were recorded and found that “Non-operative minimally invasive management of solitary and multiple liver abscesses is safe and effective”.

Qin SL et al[56] analysed patient with amebic liver abscess and said "Medical therapy alone was excellent for small abscesses, while percutaneous needle aspiration or draining was a successful approach in patients with large abscesses".

REVIEW FOR RECURRENCE OF LIVER ABSCESS:-

Cheng et al[57] studied about recurrence of pyogenic abscess and found that "Pyogenic liver abscess is more commonly recurrent in patients with underlying biliary tract disease. Irrespective of diabetic status or cryptogenic etiology, the recurrence of K. pneumoniae-infected liver abscess is low in the long-term"

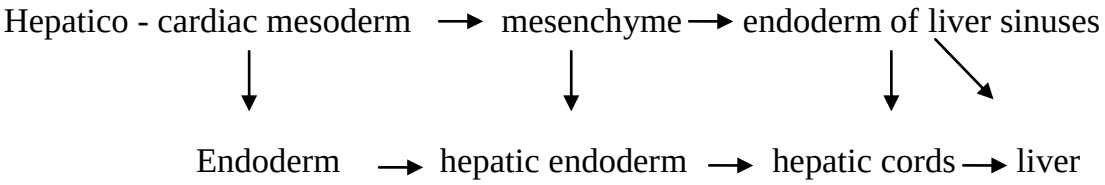
ANATOMY OF LIVER

The liver is the largest organ of the abdomen occupying the right hypochondrium, epigastrium and least part of the left hypochondium.

EMBROYOGENESIS-

Primordium of liver appears as early as 22nd day after conception. On 24th day after conception hepatic diverticulum grows into transverse septum which contains vitelline and umbilical veins. Three induction processes occur to form liver. The first induction process occurs in hepatico –cardiac mesoderm to form endoderm, followed by induction of hepatic mesenchyme to hepatic endoderm which undergoes differentiation to form hepatic cords and third induction occurs in hepatic cords to form endoderm of liver sinuses, which differentiates into hepatocytes. Migration of individual endodermal cells cause vitelline and umbilical veins to divide into plexus of vessels. On 32nd day after conception liver parenchyma taps most of the blood flow from umbilical veins and form liver sinusoids(endo thelium lined spaces).At sixth week of conception,the umbilical vein on right side gets regressed, only the left umbilical vein carries placental blood to fetus till birth. On 51st day after conception the intra-hepatic veins attain normal adult segmentation and distribution. Rapid liver growth and development makes it to bulge out of the transverse septum to become an abdominal organ. Around ninth week liver accounts for 10% of total fetal weight but at birth it weighs only

about 5% of total body weight.the intar-hepatic bile ducts differentiate from hepatic cells and join to form extra-hepatic duct system.At birth the left lobe is comparitively larger than the right lobe.Before adulthood right lobe increases in size than compared to left lobe.In new born largest brach of celiac trunk is hepatic artery but in adults splenic artery is the largest branch.In 9^{th} to 24^{TH} weeks of fetal life liver produces blood components.



GROSS ANATOMY:-

Anatomically liver weigh about 1300grams to 1500grams is divided into a left and a right lobe. The liver is shaped like a wedge with apex of wedge formed by left lobe. The left lobe consists lateral segment and the right lobe corresponds to medial, anterior and posterior segments. But on functional criteria, medial and lateral segments belong to left lobe of liver and anterior and posterior segments belong to the right lobe. The functional lobe is formed on the basis of intra-hepatic distribution of biliary ducts, hepatic artery and portal vein. Liver is covered by a capsule called glisson's capsule.

As stated earlier it lies in abdominal cavity in the right upper quadrant. It is soft in consistency and reddish brown in colour. Bile is secreted by liver and liver also performs various metabolic functions.

There are five surfaces in liver they are Superior, inferior, anterior, posterior and right. The superior, anterior, posterior and right surfaces are in contact with diaphragm and hence called as diaphragmatic surface .The inferior surface which is in contact with abdominal organs is also called as visceral surface.

Liver is divided into right and left lobes by the fissure for the ligamentum venosum posteriorly and by fissure of the ligamentum-teres inferiorly and by attachment of the falciform ligament anteriorly and superiorly. The right lobe is larger and constitutes five-sixth of the liver and consists of quadrate and caudate lobes.

RELATIONS:

i) Superior surface- related to diaphragm and following organs from left to right lung and left pleura, heart and pericardium right pleura and lung.

ii) Anterior surface- it is related to xiphoid process, diaphragm and costal margin the sixth to tenth ribbon right side.

iii) Posterior surface- related to seventh to eleventh rib and diaphragm.

iv) Right – it is lateral continuation of posterior part of liver related to diaphragm and seventh to eleventh ribs.

Visceral surface (inferior surface)- impression from stomach, duodenum transverse colon and the right kidney.

PERITONEUM - The peritoneum covers most of liver except,

i) Bare area on posterior surface of liver in right lobe.

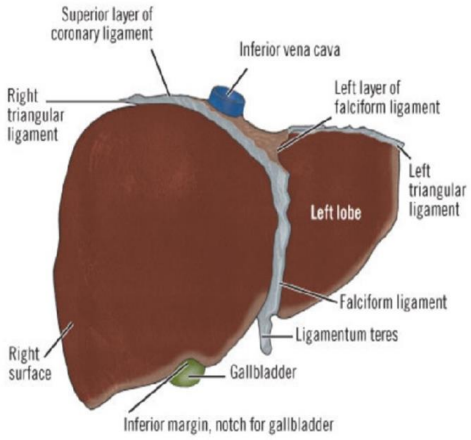
ii) fossa for gall bladder.

iii) groove for inferior vena cava

iv) coronary ligament and

v) The lesser omentum.

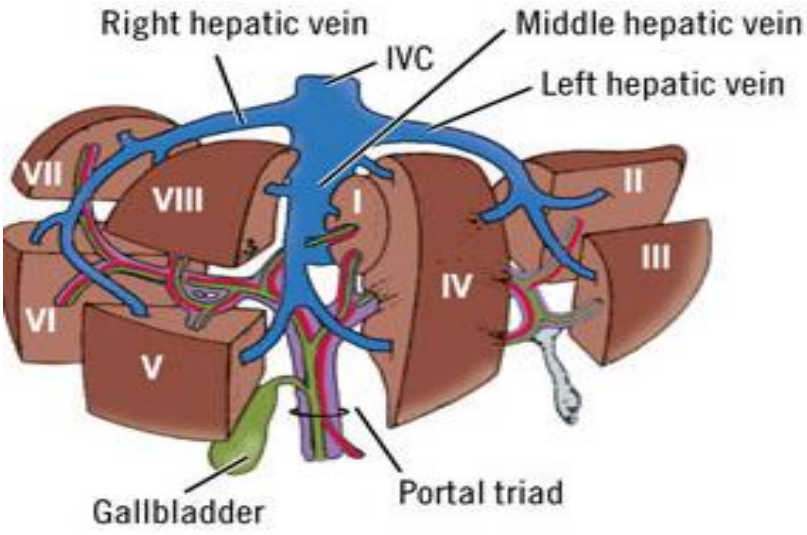
The gateway to the liver is “porta hepatis” is present in inferior surface. The inferior surface of liver has indendations which form a capital ‘H’ configuration. Left limb of configuration is formed posteriorly by fissure for ligamentum venosum and anteriorly by the fissure for the round ligament. The right limb is formed posteriorly by fossa for inferior vena cava and anteriorly by the fossa for the gall bladder.



Hepatic segments are of great surgical importance. There is 8 anatomic segments into which liver is divided. Couinaud system was based on cadaveric models, Goldsmith's and Woodburne's is based on invivo anatomic segments. Bismuth's is combination of couinaud's cadaveric and Goldsimth's in vivo nomenclature. Bismuth used the single transverse fissure and three vertical fissure which divides the liver into seven sub segments and caudate lobe was counted separately.

The segments (2 and 3) which form anatomic left lobe is separated from segments (5 to 8) or right lobe by umbilical fissure. In the main portal fissure (cantlie's line) the middle hepatic veins runs and separates right liver (segments 5 to 8) from left liver (segments 2 and 3).

The right and left functional lobes are separated by middle hepatic vein. The three hepatic veins divide the liver into four divisions with two sectors in a division. Each sector receiving a portal pedicle. The hepatic veins are intersegmental in their basis.



NOMENCLATURE AND ANATOMIC SEGMENTS OF THE LIVER			
Nomenclature			
Goldsmith and Woodburne	Couinaud	Bismuth	Anatomic Subsegment
Caudate lobe	I	I	Caudate lobe
Left lateral segment	II	II	Left lateral superior subsegment
	III	III	Left lateral inferior sub-segment
Left medial segment	IV	IVa,IVb	Left medial sub-segment
Right anterior segment	V	V	Right anterior inferior sub-segment
	VIII	VIII	Right anterior superior sub-segment
Right posterior segment	VI	VI	Right posterior inferior sub-segment
	VII	VII	Right posterior superior sub-segment

BLOOD SUPPLY:

ARTERIAL SUPPLY:

Major part (80%) of blood supply is through portal vein. Minor 20% of blood supply is through hepatic artery. But hepatic artery supplies about one-half of the oxygen to liver. Both portal vein and hepatic artery divide into right and left branches. Inside the liver they divide into segmental vessels followed by interlobular vessels which divides into

portal canals and hepatic sinusoids. The portal and hepatic arterial blood gets mixed in hepatic sinusoids. Each hepatic arterial branch is not an end artery but collateral develops even after ligation of one of branch.

VENOUS DRAINAGE:

Hepatic sinusoids drain into inter-lobular veins -> sub lobular veins -> hepatic veins -> Inferior vena cava.

There are three main hepatic veins and variable number of small veins

NERVE SUPPLY:

Hepatic plexus which has both sympathetic and para sympathetic or vagal fibres supply the liver.

TYPES OF CELLS IN LIVER:

There is 4 major cell types found in liver each with specific role.

1) Hepatocytes:

Majority of liver contains this cell type which carry out main functions of liver. They are breakdown and storage of carbohydrates, lipids and amino acids. Production of bile and detoxication of chemicals.

2) Ito (stellate) cells:

It stores vitamin A. this vitamin stored in stellate cell is responsible for liver fibrosis, liver regeneration and tumour formation.

3) Liver sinusoidal endothelial cells:

These cells line the sinuses and regulate passage of molecules between liver and blood vessel. In the space of disse the molecules needed for liver are passed to enter into hepatocytes. The endothelial cells have pores and processes called as fenestration that allow nutrients to pass from blood.

4) Kupffer cells :

These are star shaped cells that have the function in protection of liver from harmful antigens and bacteria.

RADIOLOGICAL ANATOMY OF LIVER

SONOGRAPHIC ANATOMY OF LIVER:

Size

The size of the liver has been measured by many methods, including 3D-reconstructions. Liver size measurement has no impact in daily routine because there is no reliable and reproducible ultrasound method established so far.

Shape

Described as pyramidal.

Outline

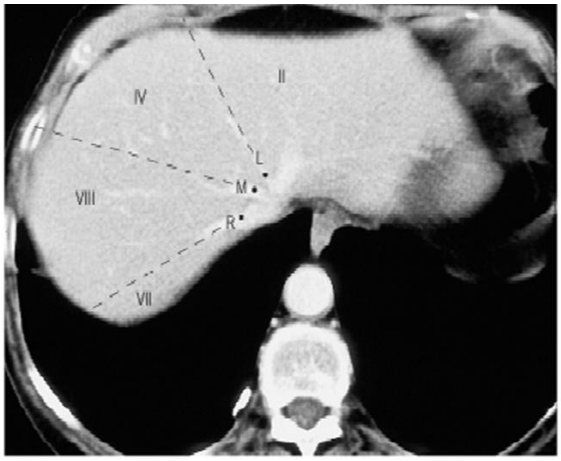
The normal liver surface should be smooth with no lumps protruding or indentations. The inferior liver border in the normal patient should be an acute angle.

Texture, echogenicity

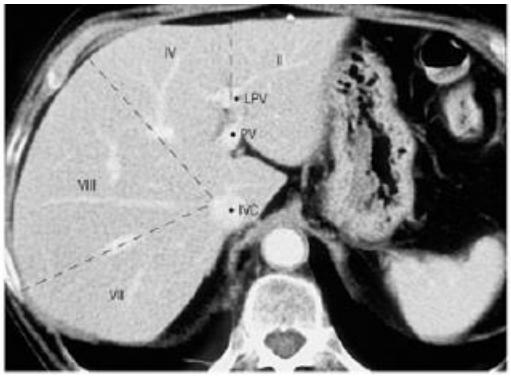
The normal liver parenchyma is of medium homogenous echogenicity, usually slightly darker than the spleen and slightly brighter than the renal cortex. It is essential when comparing the liver with the spleen and renal cortex.

COMPUTED TOMOGRAPHIC ANATOMY OF LIVER :

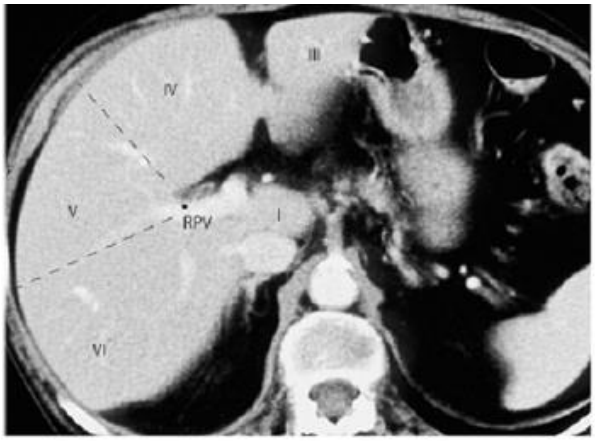
In the computed tomography liver is present from thoracic segment T7 to L2 in lumbar region but the position of liver may vary.



The transverse section at the level of confluence of left and middle hepatic veins and right hepatic vein shows segment II(present medially) and segment IV divided by left hepatic vein , segment IV and segment VIII divided by imaginary line drawn through middle hepatic vein, segment VIII and segment VII divided by right hepatic vein. The segments II,Iva,VII,VIII are superior segments.



This image is transverse section through left portal vein. the segment I or caudate lobe lies between the main portal vein (PV) and the inferior vena cava (IVC). It is at this level the left portal vein divides the left lobe into superior segments which contains segment II and IVa and inferior segments which contains segment III and IVb.



This is a transverse image through the right portal vein (RPV) which divides segments VII and VIII superiorly from segments V and VI inferiorly. This section also shows segment I.

At the level of splenic vein which is present below right portal vein only inferior segments such as segments III,IVb,V,VI are seen in computed tomography.

HISTORY OF LIVER ABSCESS

HISTORY OF AMOEBIC LIVER ABSCESS

1) 3000 BC – The Sanskrit document Brigu-samhita reffered to bloody mucus diarrhoea

2) Sixteenth century BC – Assyrian and Babylonian text reffered to blood in feces.

3) Hippocrates 356 BC – described about hepatic abscess.

4) alexander the great may have died due to liver abscess in 33 years of age and not due to malignancy.

5) 1818- Ballingall described surgical technique to drain liver abscess.

6) 1821- Napoleon died due to amoebic liver abscess.

7) 1828- James annesley gave detailed description about “HEPATIC DYSENTRY”

8) 1848 - The professor of medicine Charles morehead was the first to report a case of hepatic abscess.

9) 1857 – William budd described connection between amebic dysentery and liver abscess.

10) 1873 – friedrich losch discovered “Entamoeba histolytica” he named it after his patient

11) 1885 – in intestinal ulcer patients stephanos kartulis found amoeba.

12) 1890 – osher reported young physician who died of amoebic liver abscess.

13) 1891 – William Thomas councilman, working in john Hopkins, gave report about pathology of amoebiasis, amebic dysentery.

14) 1912 – professor of pathology Leonard Roberts reported successful treatment of both intestinal and hepatic abscess by injecting salts of ementine.

15) 1952 – Hoare reported E.histolytica had three phases.

16) 1966 – Powell demonstrated the effectiveness of metronidazole.

17) 1982 – A plant alkaloid concessine was found to kill E.histolytica.

HISTORY OF PYOGENIC LIVER ABSCESS

Liver abscess due to bacterial infection may be solitary or multiple collection of pus. Ochsner et al in1938 along with his co-workers were the first to report about person suffering from liver abscess treated by surgical intervention (surgical drainage) in modern era.

His study included 47 patients and was successful in 67% of them. With introduction of antibiotics, the conservative management become important treatment form combined with abscess drainage through surgery.

Mcfadzean et al was the first to report treatment of liver abscess in minimally invasive method during 1953. In his study a group of 14 patients underwent drainage by percutaneous method but percutaneous drainage was not accepted.

With introduction of ultrasound and computed tomography during 1960 and 1970 allowed minimal invasive drainage to become the first choice of treatment.

In present date surgical drainage has role in treatment of liver only in cases with co-exsitence of peritonitis as a result of rupture of abscess into peritoneal cavity, failed percutaneous drainage.

ETIO-PATHOGENESIS LIVER ABSCESS

Hepatic abscess can occur only in conditions which leads to disruption of mucosal barrier, impaired immunity and when normal clearance mechanism of liver fail. The hepatic clearance mechanism also consists of kupffer cells acting as a filter in removing microorganism.

Hepatic abscess can be caused due to various conditions. But they are broadly classified into:-

1) Amebic liver abscess (most common cause in tropics) caused due to Entamoeba histolytica.

2) Pyogenic liver abscess (most common cause in west) which is poly microbial (mostly)

3) Fungal abscess (occurs rarely) due to candida species.

PYOGENIC HEPATIC ABSCESS

In nineteenth century, pyogenic liver abscess was caused due to complication of inflammatory condition most commonly acute appendicitis. Nowadays due to increased use of antibiotics, biliary causes and immuno-compromised status have replaced inflammatory conditions as most common cause for liver abscess in west. But in countries like india inflammatory conditions are most common cause of liver abscess.

There are five different routes by which liver gets infected they are:

Hepatic artery due to septicaemia

Portal vein from appendicitis or diverticulitis

Biliary tree due to ascending cholangitis

Adjacent organ infection

Trauma to liver (direct)

Pyogenic abscess with no underlying pathology is termed as cryptogenic liver abscess.

Hepatic Parenchymal necrosis, hematoma following trauma, liver cirrhosis, immunosuppressive drug use, alcoholism, pancreatitis, diabetes mellitus, acquired immunodeficiency syndrome, chronic viral hepatitis and infection of other solid organs like [pyelonephritis , pancreatic abscess, acute cholecystitis, bacterial endocarditis] are often associated with pyogenic liver abscess.

Benign conditions causing liver abscess are more commonly seen in Asia. In West, malignant biliary obstruction is the most common cause of pyogenic hepatic abscess. Biliary disease is responsible for around 30-40% of all pyogenic hepatic abscess. Manipulation of the biliary tree namely biliary enteric anastomosis, percutaneous trans hepatic stents and cholangiography are risk factors for pyogenic hepatic abscess. Around 20% of pyogenic hepatic abscess is due to intestinal infection.

Cryptogenic liver abscess constitutes around 35-40% of pyogenic hepatic abscess.

PYOGENIC HEPATIC ABSCESS CLASSIFICATION ACCORDING TO MECHANISM OF DISSEMINATION

PORTAL

Appendicitis

Anorectal suppuration

Post-operative sepsis

Diverticulitis

Pelvic infection

Colonic cancer

Gastric cancer

Pancreatic abscess

Chronic inflammatory bowel disease

HEPATOBILIARY:

Acute cholangitis

Cholelithiasis

Benign strictures

Peri-ampullary tumors

Carcinoma of gall bladder.

ADJACENT ABDOMINAL PATHOLOGY

Acute cholecystitis

Gastro duodenal perforation.

Colonic perforation

ARTERIAL

Ear, nose ,throat and dental infection

Endocarditis

Vascular sepsis

TRAUMATIC

Closed or open abdominal trauma

Chemo-embolization

CRYPTOGENIC

Pyemia of Portal tract due to acute appendicitis or diverticulitis was responsible for hepatic abscess of pyogenic origin in the past but now malignancy of gastro-intestinal tract may also lead to pyemia of portal tract and development of hepatic abscess even in the absence of

metastasis. In patients with cryptogenic pyogenic hepatic abscess this phenomenon should be considered. In tropics inflammatory condition still predominate as cause of liver abscess.

Spread of infection through hematogenous method also occurs due to bacterial endo carditis and intravenous drug abuse. Immune-deficiency associated with cirrhotic liver is responsible for increased incidence of liver abscess in cirrhotic liver patients when compared to general population.

In acute cholangitis due to adjacent organ infection direct liver contamination occurs leading to pyogenic hepatic abscess.

AMOEBIC LIVER ABSCESS

Amoebic hepatic abscess is caused by a protozoa, Entamoeba histolytica which has two forms : cyst and trophozoite. The triangle of infection is caused due to :

1. Organism:

In entamoeba histolytica the infective form is cyst which spreads by feco-oral transmission via person-to-person contact, water and food. The cysts are resistant to chlorination but are destroyed by iodine, heat and drying.

2. Host :

Human being is the major reservoir of entamoeba species. Immunosuppression is an important risk factor for invasive amebiasis. But the natural course of the disease is same as in non-immunosuppresed individuals.

3. Community factors:

Poor hygiene and improper sanitation is responsible for spread of protozoal infection.

FUNGAL INFECTION

Mostly occurs due to candida species. There is increased incidence in west due to aggressive treatment with antibiotics and immno-suppresion.

MICROBIOLOGY

PYOGENIC HEPATIC ABSCESS:

In pyogenic hepatic abscess the geographic location and underlying etiology is often related to specific pathogen. An abscess due to hematogenous spread is more often monomicrobial, staphylococci followed by streptococci are most frequently isolated and polymicrobial abscess are due secondary to biliary tract disease or source originating from gastro-intestinal tract caused by aerobic gram negative organism.

The identification is by direct puncture of abscess or by blood cultures. But upto 20% of patients may show negative cultures. Positive abscess culture rates are higher than that of blood cultures. The reason for negative culture mey be poor culture technique but the use of antibiotics of broad spectrum in patients with clinical signs of infection also cause negative cultures.

Klebsiella pnemoniae is the most frequent pathogen in Asian population associated with cryptogenic abscess. It is increasing in incidence because of diabetes mellitus. It is associated with increased risk of septic metastasis. Mortality is however decreasing with proper management.

In west, E.coli is most common pathogen in both monomicrobial and polymicrobial cultures followed by streptococcus milleri.

CAUSATIVE MICROORGANISM OF PYOGENIC HEPATIC ABSCESS

GRAM POSITIVE AEROBES:

Staphylococcus aureus

Streptococcus milleri

Enterococcus species

GRAM NEGATIVE AEROBES

Klebsiella pneumonia

Escherichia coli

Pseudomonas aeruginosa

Proteus species

Enterobacter cloacae

GRAM POSITIVE ANAEROBES:

Clostridium species

Peptostreptococcus species

GRAM NEGATIVE ANAEROBES:

Bacteroides species

Fusbacterium species

In amoebic hepatic abscess three virulence factors contribute to course of disease they are :-

small peptides (Ameba pores)

Cysteine proteases

A surface protein(lectin)

Lectin is responsible for colonic wall adhesion of trophozoite which causes persistent infection and activation of caspase 3 which leads to cell necrosis and formation of abscess. Trophozoites insert amoeba pores into host cell which is responsible for colloid osmotic lysis of the cell. Cysteine proteases cause disruption of monolayers of cell and extracellular matrix degradation. When neutrophils are present along with E.histolytica there is increase in liver cell necrosis.

Proteophospoglycans present in amebic glyco-calyx contribute to pathogenicity of E.histolytica because antibodies which attach to proteo-phosphoglycans prevent hepatic abscess formation.

Absence of tight junctions in hepatic sinusoidal endothelial cell enhance crossing of the parasite to liver parenchyma.

PATHOLOGY:-

The most common extra-intestinal form of invasive amoebiasis is the formation of amoebic hepatic abscess due to infection of E.histolytica. trophozoites that penetrate the mucosal barrier of colon cause invasive disease in the liver through portal system. The hepatic abscess is usually solitary and present in segments V,VI,VII,VIII of liver which constitutes the right lobe because spread of colonic infection through right portal tract(superior mesenteric vein) reaches the right lobe.

Both amoebic colitis and amoebic hepatic abscess rarely occur simultaneously only one of them predominates in people and colonic lesion are usually silent in such cases.

It starts as diffuse amebic hepatitis leading to liquefactive necrosis strating from center to periphery. The anchovy sause pus is due to liquefied liver tissue which has no odour and is sterile. The extensiom of abscess is due to lysis of neutrophils and release of neutrophilic mediators.

The glisson capsule is resistant to amebae and biliary and vascular structures with intrahepatic covering of glisson capsule which traverse the abscess cavity may be mistaken for septa within abscess cavity. Injury to these structures cause communication and internal fistula formation leading to biliary leak or haemorrhage. The wall of abscess is made of fibrous tissue because of minimal host response it is very thin.

CLINICAL FEATURES

Pyogenic liver abscess:

Nonspecific symptoms often predominate in abscess. Non specific symptoms are found more often in cryptogenic liver abscess. The most frequent clinical symptom is fever.

Symptoms are :-

Fever with or without chills

Abdominal pain

Nausea and vomiting

Jaundice, if present may be an indicator of systemic septic response.

Significant differences are not noted between clinical features of solitary and multiple abscess.

Amoeic liver abscess:

It is a disease of males in young age. Clinical features are similar to pyogenic liver abscess. The time from penetration of colonic mucosa and formation of abscess is not known.

INVESTIGATIONS:

PYOGENIC LIVER ABSCESS-

Raised white blood cell count is seen in around 70–90%,liver function test will show elevated alkaline phosphatase levels (80%), and an elevated bilirubin (indicator of systemic sepsis) and transaminases (50-60%). Usually normocytic normochromic anemia is seen, hypoalbuminemia, and prolonged prothrombin time are also seen in these patients.

AMOEBIC LIVER ABSCESSS-

These Patients present with a mild to moderate elevation ofthe white blood cell count when compared to pyogenic liver abscess because the body mounts only poor immune response and anemia. Initially, alkalinephosphatase will be normal and alanine aminotransferaselevels will be elevated reverse occurs in patients with chronic disease. Jaundice is rare. Amebic abscessesinvolve severe destruction of liver parenchyma and usually largerthan pyogenic abscesses, So patients will have an elevated prothrombin time. If colitis is present, wet mount preparations of stool samples may contain trophozoites in about 30% of the time in one sample and 70% of the time if atleast three samples are tested. Liver abscesses are associated with positive stool samples in50% of cases.

SEROLOGY

Serum antibodies will be positive in patients with liver abscesses. But countries with a high prevalence of amebiasis also have a high prevalence of positive serologies even in asymptomatic individuals. Biopsies of the edge of an ulcer or the wall of an abscess reveal trophozoites with periodic acid-Schiff - stain

RADIOLOGICAL APPERANCE OF LIVER ABSCESS :-

Abscess in liver vary according to severity of disease. In early stages there is hypoechoic solid space occupying focl lesion surrounded

by oedematous liver tissue and distortion of echotexture of liver in that area.

As infection progresses there is necrosis of liver tissue the abscess appears homogenous and maybe mistaken as tumour but with liquefaction the fluid content accumulates and so the abscess cavity show posterior enhancement. The presence of gas can be found in infection with gas forming organism i.e. klebsiella gas consists of nitrogen, carbon dioxide, oxygen and hydrogen which may be due to mixed acid fermentation of glucose leading to gas formation.

The abscess in general are hypo-echoic,oval or round with well defined margins. Doppler study is done with ultrasound which shows abscence of any signal in abscess cavity to rule out vascularity in case of tumour.

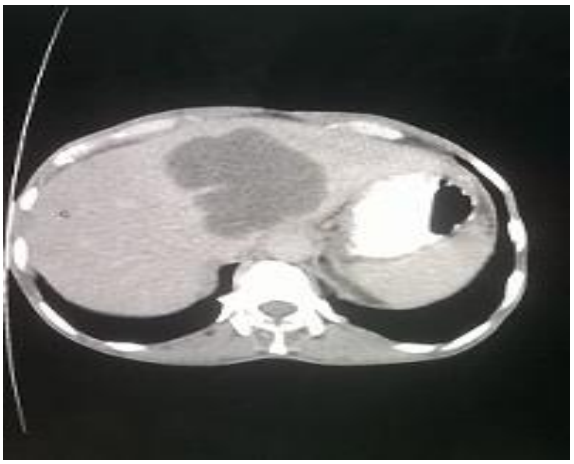
FIGURE SHOWING USG IN LIVER ABSCESS

The clinical diagnosis is important because the appearance of abscess in ultra-sound can be similar as for hematoma or necrotic tumours.

Sometimes the abscess may show hyper echogenicity due to corresponding necrotic areas in early stages.

Computed tomography is done when diagnosis has not been reached by other methods. In computed tomography amoebic abscess has low attenuation values(0 to +30 hounsenfield units).

FIGURE SHOWING CT-IMAGE IN LIVER ABSCESS



In Magnetic resonance imaging homogenous low signal intensity in T1 weighted images and mural enchancement following administration of contrast agent and high signal intensity in T2 weighted images is seen in liver abscess. There may be perilesional edema in T2 weighted images.

Nuclear scintigraphy are useful in septic patients were localising signs are absent. Gallium 67 and Indium 111 are standard isotopes to

detect abscess. The major disadvantage of nuclear studies is that they provide poor anatomic detail.

ULTRASOUND GUIDED PERCUTANEOUS DRAINAGE

Intra abdominal abscess is caused due to various pathologies but the pathophysiology is similar either an exsiting intra-abdominal fluid collection becomes superinfected or an infectious nidus forms an abscess cavity denovo.

The mature abscess cavity is encapsulated by a wall of collagen, fibrin, leucocytes and neovasculature. The wall tries to confine the septic focus under the influence of enzymes and leukocyte action the contents of the abscess become liquefactive due to liquefaction the pressure within the abscess cavity increases and makes the abscess cavity to assume a ovoid or spherical configuration.

Large abscess cavity can displace surrounding viscera to facilitate a direct percutaneous approach.

In the past percutaneous abscess drainage was not well accepted by surgeons because of risk of peritonitis due to rupture of wall and spill of abscess contents leading to peritoneal contamination, chance of injury to inferior vena cava and misconception that large cavities cannot be drained by small bore catheters but now it is understood that the wall is preserved during percutaneous abscess drainage.

LAW OF PERCUTANEOUS ABSCESS DRAINAGE :

Poisseuille"s law which states that "the velocity of flow within a tube is related to the diameter of the tube and viscosity of fluid" pus follows this law like any fluid with laminar flow through a tube.

The main advantage of large bore catheters over small bore catheters is that they drain pus more quickly but small bore catheters are easy to place percutaneously and are better tolerated by the patient. The intial decompression of the abscess cavity is the main therapeutic effect attained from large bore catheters but when the abscess is mature the viscosity of abscess fluid is low and can be drained by small bore catheters itself.

ABSCESS DRAINAGE PRE-PROCEDURE PRINCIPLE :

1) The abscess should be mature with well defined wall.

2) The size and location of abscess and safe route of drainage through imaging should be known.

3) Coagulation profile should be within normal limits.

4) Drugs which increase prothrombin time should be stopped 5 days before percutaneous abscess drainage.

TECHNIQUE OF ABSCESS DRAINAGE :

The two most important things in the aspect of percutaneous drainage placement is

1) The type of image guidance to be used

2) The technique of catheter insertion

    a) the seldinger technique

    b) the trocar technique

The majority of abscess can be accessed using guidance of ultrasound we should use a needle with a high echogenic tip to assist in needle visualisation. Advantages of ultrasound guidance in percutaneous abscess drainage are :-

i) it provides real time imaging so that we can re-evaluate the approach and visualise adjacent organs until the abscess has been reached.

ii) it gives more flexibility because easily changing the orientation of ultrasound probe gives more information about access route.

iii) can allow access to deeper collection

Disadvantages of ultrasound guidance in percutaneous drainage are they are highly operator dependent and overlying bowel gas degrade ultrasound quality.

Computed Tomography guided percutaneous drainage offers higher resolution images to operator for planning and performing percutaneous abscess drainage. If the antero-posterior angle is not feasible the CT gantry angle can be adjusted to optimize the approach.

Whatever the guidance technique is, the approach should be shortest and safest route while the bowel and other vital oragns are avoided. In the most dependent position of the abscess the catheter tip is positioned and tip of the catheter should be placed in location most distal to the entry site of catheter because as the cavity collapses, the catheter may be withdrawn without any need for another drain. Suction and irrigation usually augment percutaneous abscess drainage.

The two main methods for catheter placement are

i) The trocar method

ii) Seldinger method

The patient is prepared under sterile aseptic precaution draped and superficial tissue are anaethsized. A small skin incision is made, the trocar method involves placement of catheter directly into the collection over a sharp metal trocar and cannula which is also made of metal and

stiffened. Then catheter is advanced forward from trocar and stiffener into the abscess after confirming position of catheter by imaging (ultrasound) as well as flow of pus through cannula. The catheter is then fixed to the skin using 2-0 silk and then contents are aspirated.

The seldinger technique involves placement of guide wire into the abscess through an access needle dilatations are done serially over the guide wire and until the catheter is advanced over the wire into the abscess. The position of catheter is checked by ultrasound and/or with fluoroscopy by injecting a small amount of radio-opaque contrast always aspirate cavity before injecting contrast.

Abscessograms through catheter make sure that all the side holes of the catheter are entirely within the abscess cavity and minimize the risk of peritoneal contamination.

The catheter is then connected to a drainage bags and placed to suction drain or gravity or gravity drainage. There is also three way stopcock between the drainage bag and catheter to facilitate drain irrigation. By instillation of 4 to 6mg tissue plasminogen activator reconstituted in 10 to 20 ml of saline we can break down the fibrin within the abscess cavity and thus reduce the viscosity of pus which facilitates drainage.

Once in position the patient and catheters are followed up daily by ultrasound. The catheter is flushed with 5 to 10 ml normal saline to prevent clogging three times a day.

Gravity drains usually have minimal incidence of catheter occlusion due to aspiration of debris compared to suction drain but use of suction drain can result in more rapid reduction of abscess size and can oppose the walls of the cavity thus facilitating collapse of the cavity.

The catheter can be removed on the basis of combination of clinical and radiological criteria. They are: -

i) The drainage should be less than 10ml per day minus the catheter flush volume.

ii) Leucocytosis and fever associated with abscess should be absent.

iii) evaluation of residual cavity size and presence or absence of any biliary fistula should be done with an abscessogram or imaging. If any fistula is noted catheter drainage is continued till the fistula closes.

If the patient is clinically stable and cavity is collapsed with minimal output from cavity the catheter can be removed.

COMPILCATION ASSOCIATED WITH PERCUTANEOUS ABSCESS DRAINAGE: -

i) sepsis

ii) bowel injury

iii) failure of drainage

iv) catheter malposition

v) haemorrhage

vi) pneumothorax

vii) hemothorax

viii) cardiorespiratory arrest

ix) peritonitis

Failure of drainage of abscess is usually due to characteristics of the collection rather than the technique. The abscess may not be mature and liquefied enough to drain effectively or may be multilocular. Other causes are fungal contamination and presence of necrotic tumour.

TYPES OF CATHETER:-

In percutaneous abscess drainage two main catheters are used they are :-

i) double lumen sump catheters

ii) single lumen

The catheters are available from 8-16 french in diameter.

Catheter have hydrophyllic coating which allows for easier insertion and these are most commonly used.

The hydrophyllic coating is responsible for absorption and retention of water and thus reducing friction coefficient upto a factor of 20. Two most common catheter configuration are “j-tip design and locking pig-tail” design.

The double lumen sump catheters are designed in such a way to drain an abscess using suction. This catheter is mostly used when material within the cavity is viscus and thick.

The mechanism of this sump catheter is a venting effect on second lumen of catheter because when a catheter is placed in suction the walls of cavity collapse thereby reducing suction, the presence of second venting lumen allows air to be sucked and thus prevents adherence of catheter to cavity walls and cause more effective drainage.

FIGURE SHOWING PIG-TAIL CATHETER IN RIGHT LOBE LIVER ABSCESS

FIGURE SHOWING PIG-TAIL CATHETER FOR LIVER ABSCESS INVOLVING RIGHT AND LEFT LOBE

In our study the trocar method of 10-12 french pig tail type catheter placement is used under ultrasound guidance after confirmation of abscess with computed tomography in patients with normal coagulation study and connected to a gravity drains.

STUDY PROTOCOL

This will be a CLINICAL PROSPECTIVE STUDY of 56 patients done at KMCH between January to September 2016.

METHODS OF COLLECTION OF DATA (INCLUDING SAMPLING PROCEDURE):

A. Study Design: Prospective cohort study.

B. Place of study: Govt. Kilpauk Medical College and Hospital, Chennai.

C. Study sample size: $N = Z^2 P\{1-P\} / d2 = 56$ with 95% confidence interval z value is taken as 1.96

P= Propotion of people with reduction of abscess 70 %

D= absolute error 12%

So applying these variables in the formula sample size is 56.

SAMPLE SIZE : 56 (selected by Random sampling method)

D. Study period : 9 months (January to September)

E. Selection criteria :

First 56 patients admitted during the period of study.

METHOD OF COLLECTION OF DATA:

* 56 eligible patients are chosen.

* Clinical assessment done at time of inclusion in the study.

* Detailed history and examination done.

* Diagnosis to be confirmed by ultra-sonogram of abdomen.

* Pus drained will be sent for culture and sensitivity appropriate antibiotic coverage will be given.

* Basic routine investigations and coagulation profile will be done.

* Consent will be obtained for inclusion under study

STEPS OF CATHETER DRAINAGE:-

Procedure was performed using the trocar technique with pig-tail catheter as described earlier with two person (a surgeon and a radiologist).

Abscess was localized by Ultrasonogram and a safe drainage route planned to avoid to avoid other intra-abdominal organs.

Under strict antiseptic precautions, the site was marked and infiltrated with 2% lignocaine.

A stab incision (5mm) was made through which trocar along with pigtail catheter is passed till it reached the center of the cavity. Position

of the catheter in abscess cavity confirmed under sonographic guidance. The trocar is then withdrawn and the pigtail catheter was connected to a closed drainage bag and fixed to the skin. Sterile dressing was applied. The pus was sent for aerobic culture.

FIGURE SHOWING THE PROCEDURE OF PIG-TAIL CATHETER DRAINAGE

The daily output was monitored. The catheter was flushed daily with 10 ml of normal saline to prevent its blockage with debris. Metronidazole, broad spectrum antiobitics are were given in therapeutic doses for a period of 2-4 weeks. Alternate day Ultrasonogram studies were done to monitor the cavity size and volume and to confirm the position of tip of the catheter. Clinical improvement in the patient's condition was noted.

The pigtail catheter was removed when drainage become serous and it either ceased or was minimal (<10 ml in 24 hrs) and USG was suggestive of reduced size of cavity(70%). During removal of the

catheter, sterile dressings were applied. All patients were followed up and were assessed clinically and ultrasonographically.

INCLUSION CRITERIA

- Patients of both sexes
- Age from 20 years to 60 years
- Abscess size more than 5cm
- Recurrent abscess

EXCLUSION CRITERIA

- Patients below age of 18 and above the age of 60 years
- Patients of suspected malignancy.
- Patients with coexisting coagulopathy
- Ruptured liver abscess with features of peritonitis

PROFORMA

Patient name :

IP No:

Department:

Hospital:

Age:

Sex:

Occupation

Chief complaints:

Past history:

General examination.

11. Vitals.

12.Abdominal examination

INSPECTION -

PALPATION -

PERCUSSION -

AUSCULTATION -

12.Cardiovascular and respiratory system examination :

13.INVESTIGATIONS:

Complete hemogram

Urine routine

Blood sugar

Blood urea and creatinine

Serum electrolytes

Liver function test

Coagulation profile

Viral makers

USG abdomen

CT abdomen

PUS CULTURE AND SENSITIVITY

14.Diagnosis:

CATHETER DRAINAGE	
1)PAIN SCORE (USING VISUAL ANALOUG SCALE):	
2)Disappearance of abscess(no of days)	
3)Time for defervescence of fever(no of days)	
4)Size of abscess(volume)	
5)Time to return to physical activity(no of days)	

DATA ANALYSIS

Collection of data was done. The abdominal pain, mean reduction of size of the abscess before and after the procedure were and time for deffeverense of fever, disappearance of abscess and time to return to normal activity, recurrence if any is also noted, for all the 56 patients and were entered into the Microsoft excel sheet. The values were used for analysis.

The Paired student T –test was used to analyse the values collected before and after the procedure from t-score and degree of freedom of difference in mean reduction of abscess size. The software tools used for the purpose were downloaded from the internet. The values obtained were confirmed using IBM SPSS software to check the validity.

The mean of the two groups, the standard deviation, standard error of mean,t-score and the P-value were calculated. The results were again converted into bar diagrams, pie charts, and scatter map for the sake of easy understanding , and are presented as follows.

RESULTS

Of the 56 patients enrolled in the study, 48 were male and 8 were female patients. The most common age group was 41-50 years among both male and female groups followed by the age group of 51-60 mean age was 46.625.

There were no major per-operative complications. There were no major postoperative complications in the patients There was wound infection at the catheter site in one patient which was treated conservative with antibiotics, in 2 patients catheter has come out through the skin due to breakage of surgical suture whike the patient changed his position from one side to other they had to undergo reprocedure,1 patient had catheter blockage due to debris and it was replaced by a larger size catheter.

The mean hospital stay was 10.16 days we did not wait for complete resolution of cavity once the size of the abscess has reduced 70% the treatment was considered successful.

The size of the abscess of the patients before procedure ranged from 240cc to 1130cc, with the mean of 520.571. The standard deviation was 201.5 and standard error of mean was 144.67 and the standard error of mean being 3.598214.

The size of the abscess of patients after 1week from procedure ranged from 40cc to 620cc . The mean of size of abscess 237.71. The

standard deviation was 237.714 and the standard error of mean being 2.290732.

The difference in the mean between the two groups was 279.527. The p- value was 0.00001 (<0.05). Hence the value was statistically extremely significant.

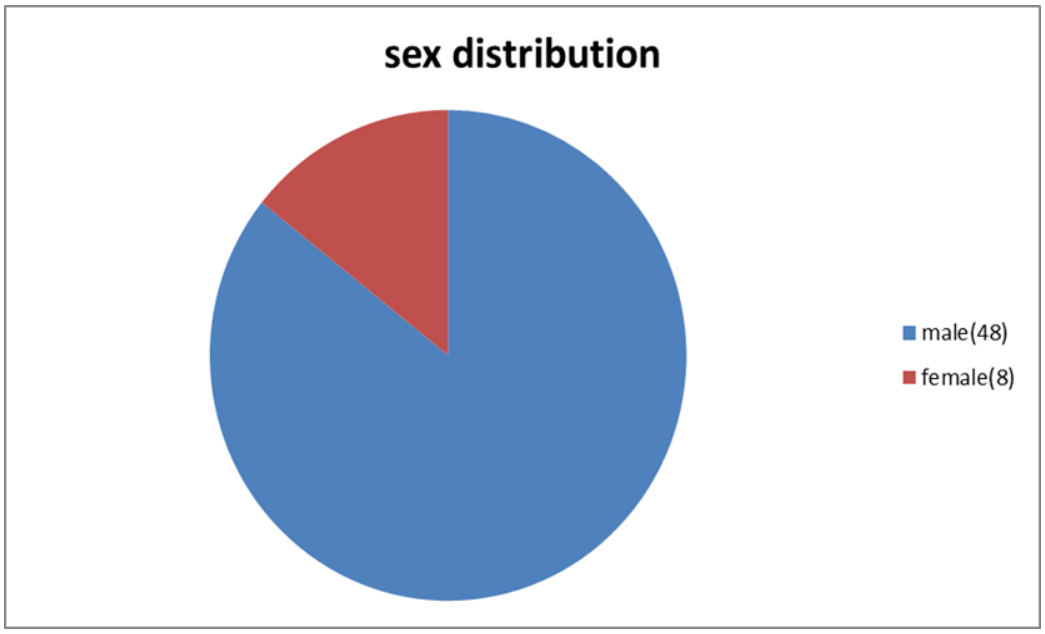
The table below shows distribution of patients characteristics, investigations and abscess size.

Patient characteristics, investigations and abscess characteristics	**Percutaneous catheter drainage(n= 56)**
Age:	
mean	46.625
median	46
Male: female	48:8
Risk factors	
Diabetes	10
Biliary stones	6
Alcoholism	28
Viral hepatitis	3
Previous gastro-intestinal surgery	1

Patient characteristics, investigations and abscess characteristics	**Percutaneous catheter drainage(n= 56)**
Clinical features	
Abdominal pain	54
Fever	51
Anorexia/malaise	46
Jaundice	4
Nausea/vomiting	20
Investigations(median[range])	
Haemoglobin	9.8(7-12.4)
Total leucocyte count(cells/mm3)	12,400(11,000-20,000)
PT- INR	1.9(1.0-2.5)
Bilirubin	1.7(0.6-2.4)
Aspartate aminotransferase (IU/L)	45(18—68)
Alanine aminotransferase (IU/L)	47(27- 74)
Serum alkaline phosphatase (IU/L)	197(70- 266)
Total protein	5.4(5-6.4)
Abscess(n)(solitary : multiple)	54:2
Location (Right: left : multiple)	42:12:2
Nature (amoebic: pyogenic)	36:20

CHART - 1

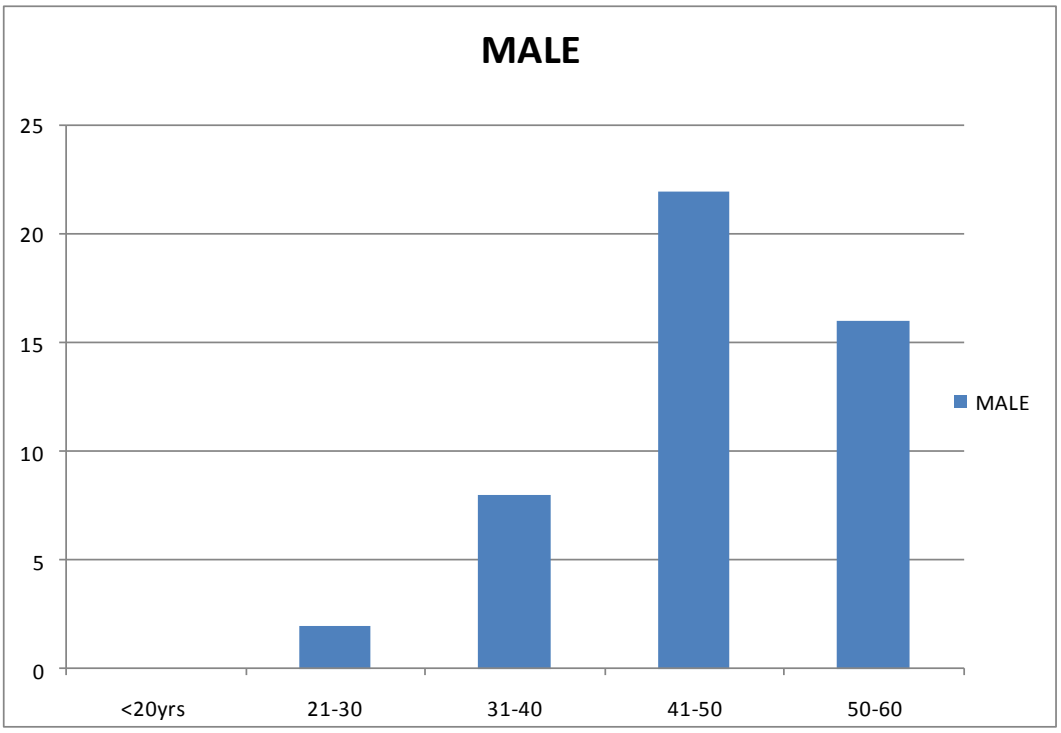
SHOWING SEX DISTRIBUTION IN PATIENTS WITH LIVER ABSCESS



The incidence of male patients is about 85% when compared to female patients with liver abscess.

CHART - 2

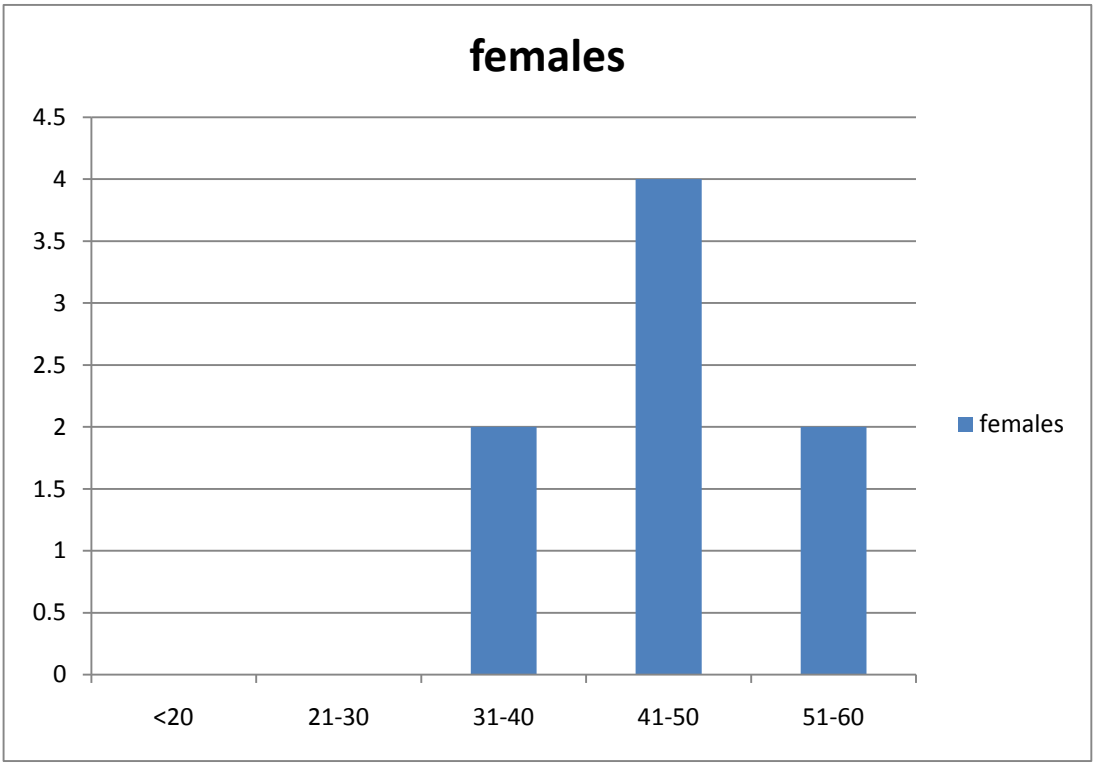
SHOWING AGE DISTRIBUTION IN MALE PATIENTS WITH LIVER ABSCESS



The incidence of male patients with liver abscess in more 41-50 years of age.

CHART - 3

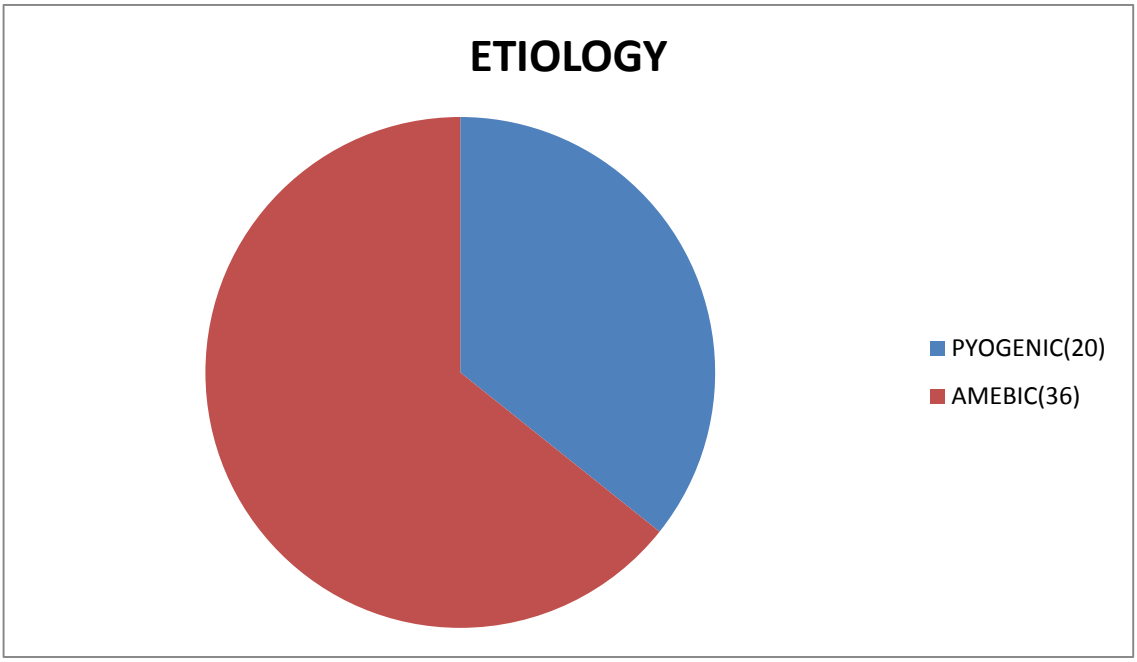
SHOWING AGE DISTRIBUTION IN FEMALE PATIENTS WITH LIVER ABSCESS



The incidence of female patients with liver abscess in more 41-50 years of age.

CHART - 4

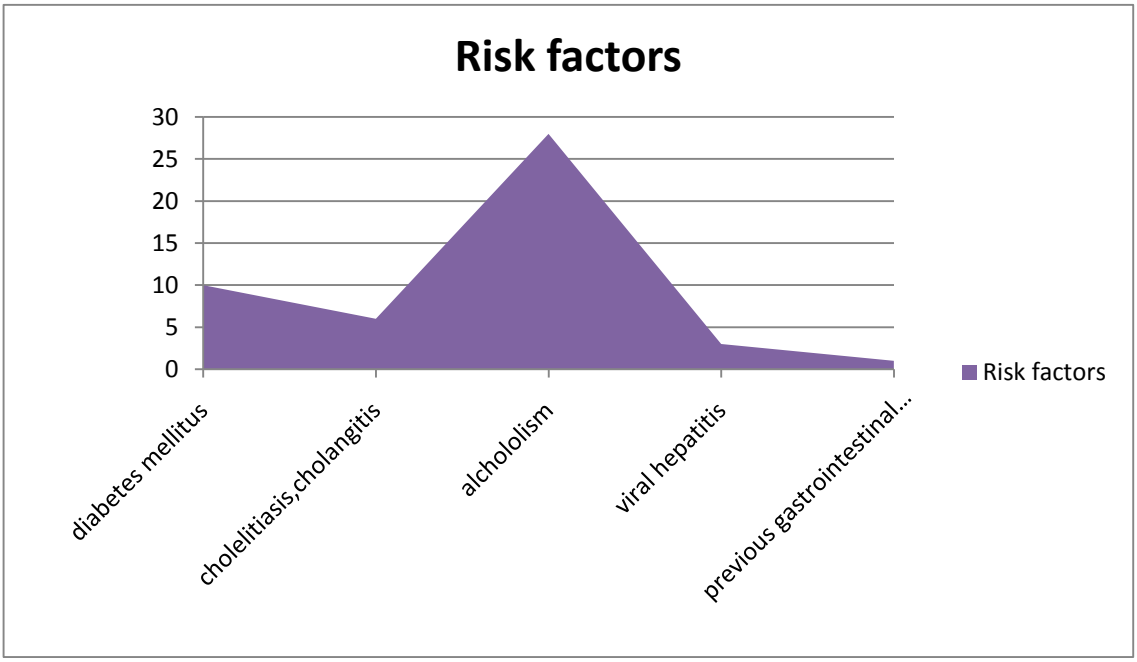
SHOWING DISTRIBUTION IN ETIOLOGY AMONG PATIENTS WITH LIVER ABSCESS



In our study amoebic liver abscess was found to be more prevalent about 64.28% in patients with liver abscess.

CHART - 5

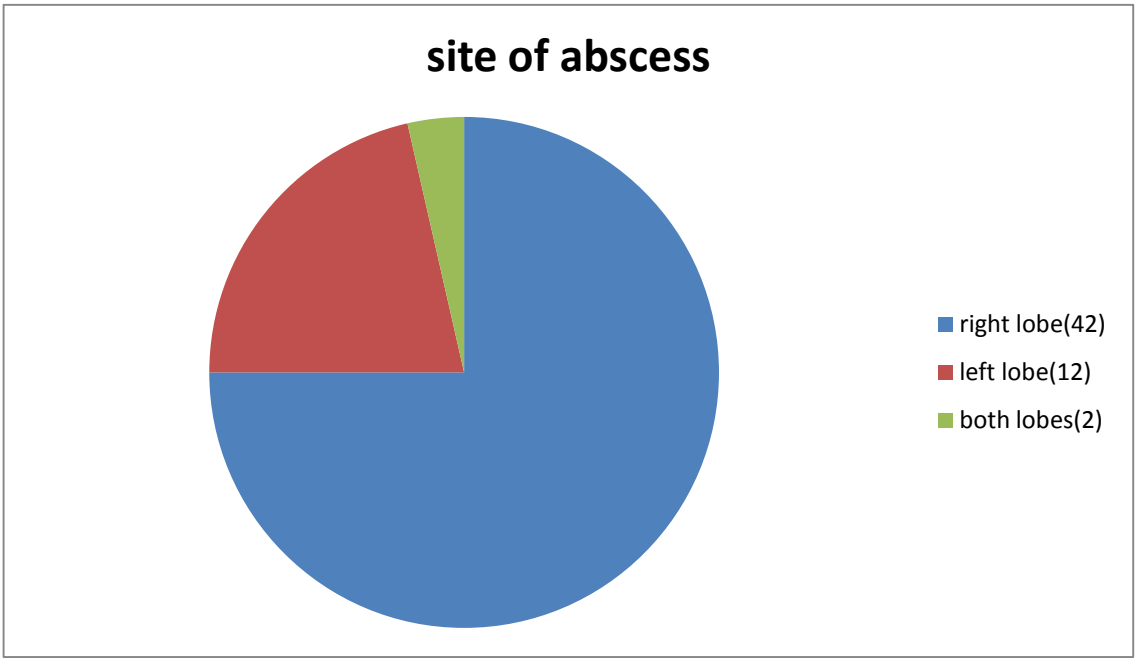
SHOWING DISTRIBUTION OF RISK FACTORS AMONG PATIENTS WITH LIVER ABSCESS



In our study alcoholism was found to be more prevalent in about 50% patients with liver abscess.

CHART - 6

SHOWING DISTRIBUTION OF SITE OF ABSCESS AMONG PATIENTS WITH LIVER ABSCESS



In our study Right lobe of liver was found to be more involved in about 78.57% patients with liver abscess.

CHART - 7

SHOWING REDUCTION IN ABDOMINAL PAIN IN PATIENTS WITH LIVER ABSCESS TREATED BY PRECUTANEOUS DRIANGE

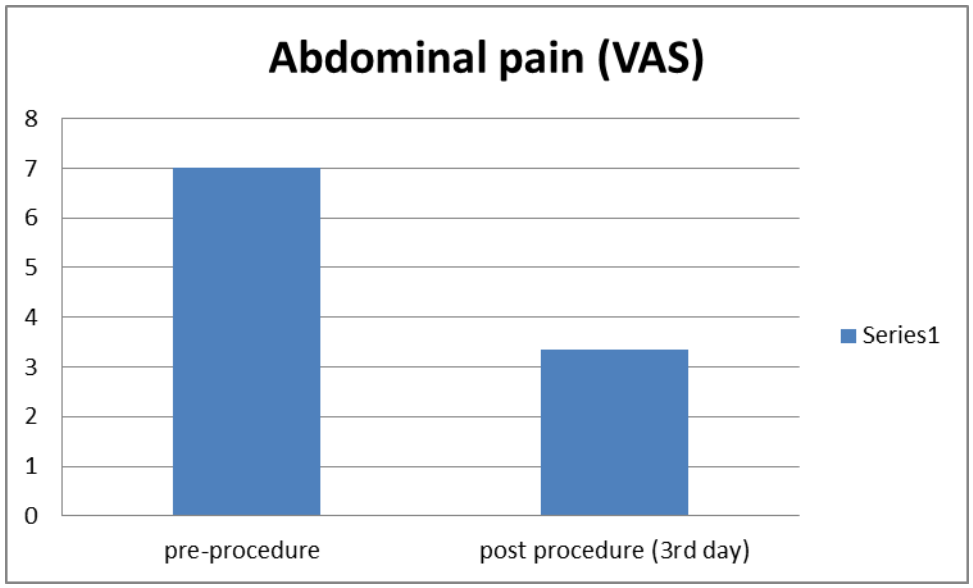
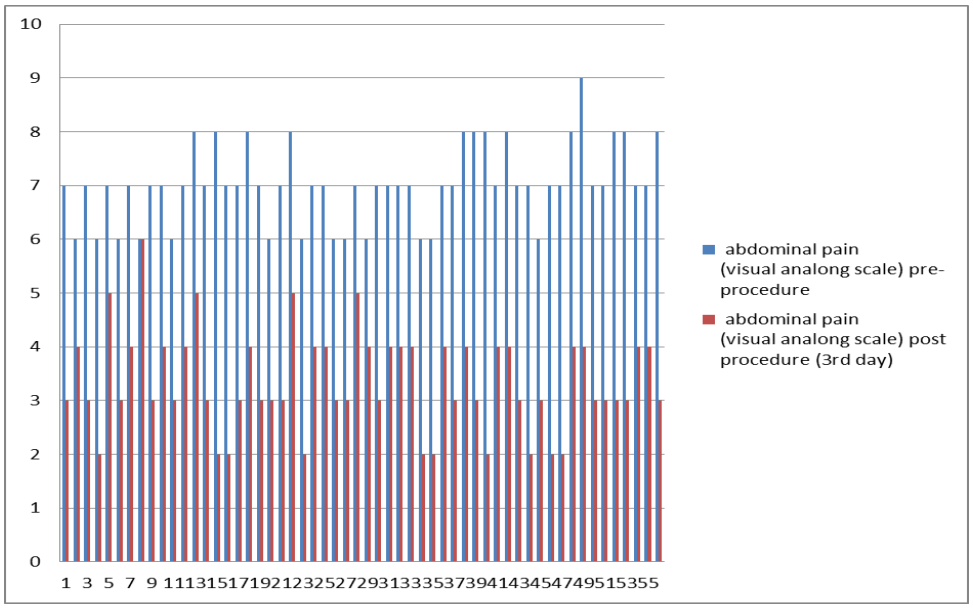


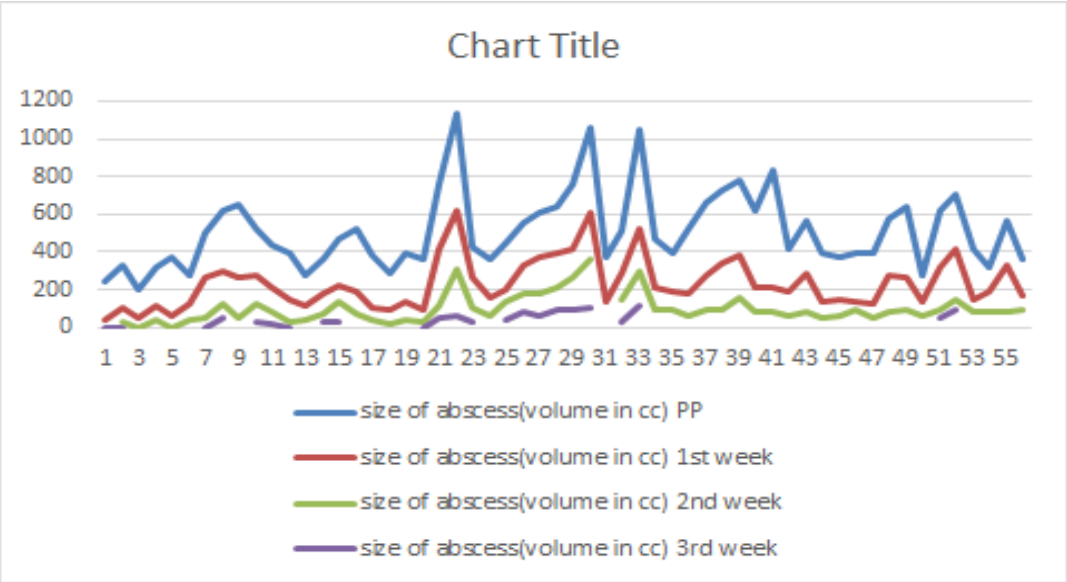
CHART - 8



In our study there is reduction in abdominal pain in patients treated by precutaneous drainage.

CHART - 9

SHOWING REDUCTION IN SIZE OF ABSCESS IN PATIENTS TREATED BY PRECUTANEOUS DRAINAGE

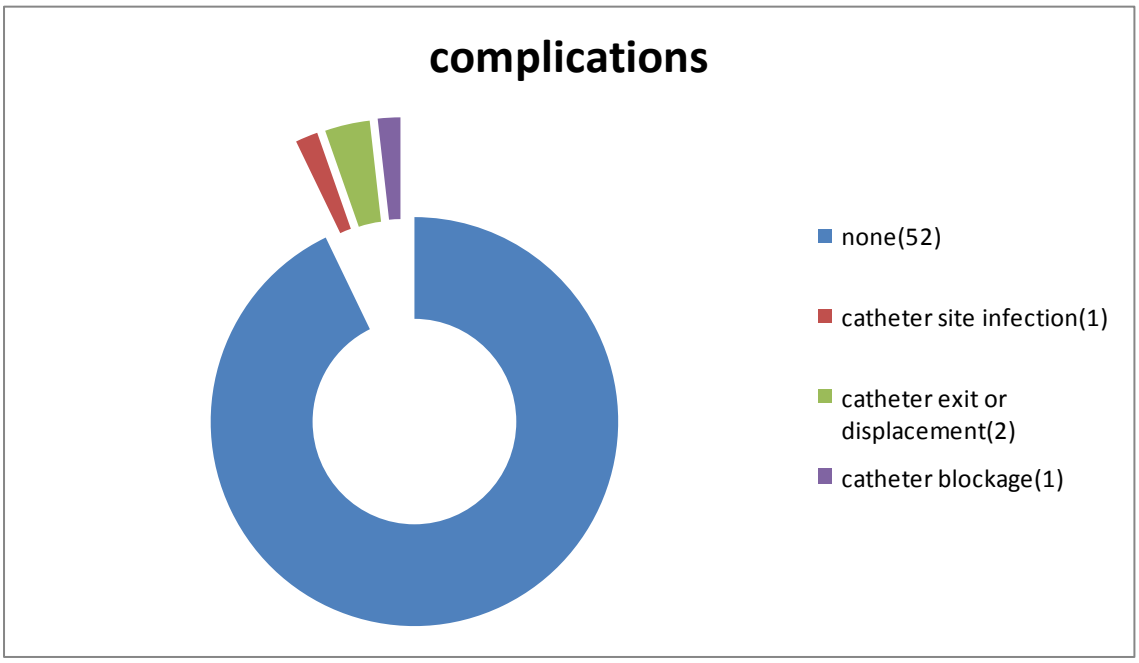


In our study mean reduction in size of abscess by precutaneous drainage.

Size of abscess in First week vs pre-procedure	Size of abscess in second week vs First week	Size of abscess in third week vs second week
279.5273	138	107.2381

CHART - 10

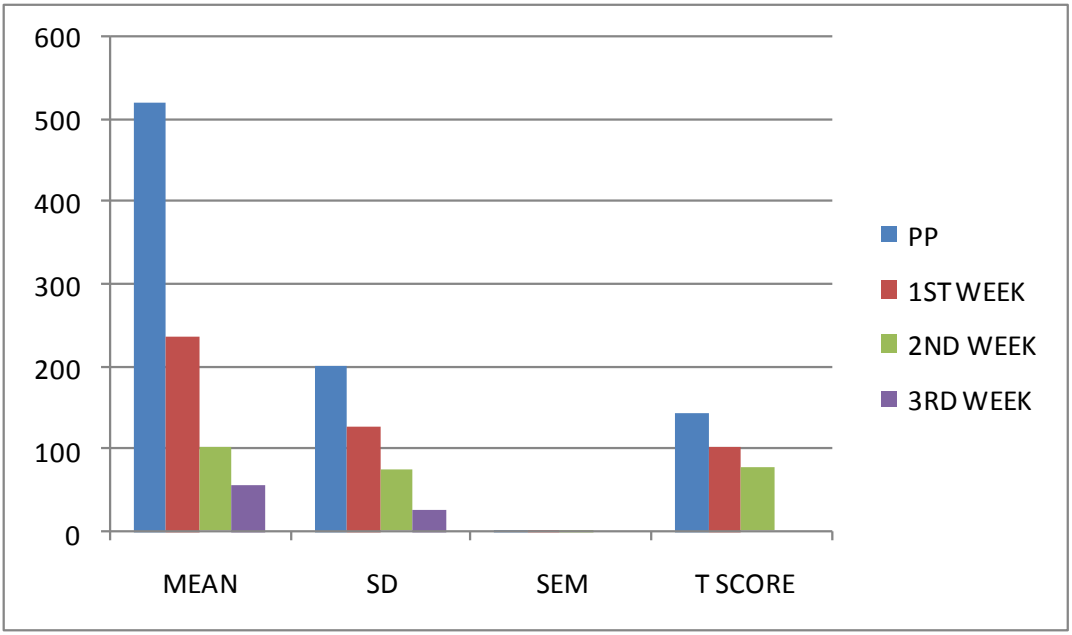
SHOWING DISTRIBUTION OF COMPLICATIONS AMONG PATIENTS WITH LIVER ABSCESS



In our study there were only 4 complications all are treated by conservative method.

CHART - 11

SHOWING DECREASE IN SIZE OF ABSCESS



This chart shows there is mean reduction and size of abscess.

size of abscess (volume in cc)	MEAN	SD	SEM	T SCORE
PP	520.5714	201.5	3.598214	144.675
1ST WEEK	237.7142857	128.281	2.290732	103.7722
2ND WEEK	102.6037736	74.13743	1.32388	77.50232
3RD WEEK	56.95238095	27.14125		

Difference in size of abscess	Size of abscess in First week vs pre-procedure	Size of abscess in second week vs First week	Size of abscess in third week vs second week
mean	279.5273	138	107.2381
stan dev	98.78069	69.81586	63.29763
stan err	13.20012	9.329537	13.81268
t-score	21.17611	14.79173	1.694188
p-value	<.ooo01	0.00001	0.00001

P-value was calculated by T-score method and was found to be statistically significant.

DISCUSSION

This is a prospective observational study on the outcome of percutaneous catheter drainage for treatment of liver abscess conducted from January 2016- September 2016. The results of our study were compared with similar studies and discussed below.

In study conducted by us the percentage of male patients was significantly higher 85.72% than female patients who constitute about 14.28%. Percentage of male patients were higher than female patients in all other groups. Highest percentage of male patients were in 41-50 years. This was owing to the fact that most patients are alcoholic's and undiagnosed diabetes mellitus is common in this age group.

Sharma MP et al [1]stated that hepatic abscesses continue to be an major cause of morbidity and mortality in the tropical countries. Presentation of patients is usually late when the liver abscess attains a large size and also said that though treatment of amebic liver abscess is medical 15% are refractory to medical treatment and require drainage . In our study also most patients presented late with large abscess size and were resistant to medical treatment.

Alvarez JA et al[2] studied comparison of older and younger Patients with Pyogenic liver abscesses and found that there is no difference in the mortality rate due to liver abscess among different age groups. But older patients tend to have higher incidence of intra-

abdominal pathologies. This was in supportive to our study in which there is no difference in management of liver abscess among different age groups and size of the abscess was most important determinant in predicting days to achieve clinical success.

Cerwenka H et al[3] said that microbiological testing helps in provides important information for treatment monitoring and change of antibiotics. This helps in change of antibiotics in our study.

Chen SC et al[4] studied about Pyogenic liver abscesses associated with Escherichia coli and said that Escherichia coli infection is more common in the biliary tract group. In our study E.coli was most commonly seen in patients presenting with cholangitis and cholelitiasis. Cheng HC et al also said that e.coli associated liver abscess is more common in biliary tract disease

Li J et al[5] studied about diagnosis and therapeutic choice of Klebsiella pneumoniae liver abscess and found that diabetic group had a higher rate of Klebsiella pneumoniae infection and a lower rate of Escherichia coli infection than the biliary tract group.which was similar to that found in our study were klebsiella infection was more commonly found alcholics and diabetic patients.. Liew K et al[8] conducted study on Pyogenic liver abscess in tropical centre's Klebsiella pneumoniae was the most common etiological agent in pyogenic liver abscess

Ferreira JP et al[18] said that Staphylococcus aureus are found in of the liver abscesses.

Resulting from hematogenous dissemination of bacteria that's infecting some other organ underlying conditions most frequently found were biliary diseases, followed by recent abdominal surgery. This was in accordance with our study in which S.aureus was found patient with history of cholecystemy in recent past but it also found in patients with diabetes mellitus.

Cosme A et al[8] studied about Pyogenic versus amoebic liver abscesses and found that the parameters suggesting pyogenic origin were: age 50 or older, male gender, diabetes, moderately elevated bilirubin and transaminases. In amoebic cases the associated features were being aged 45 or younger, diarrhoea, and presence of a single abscess in the right lobe. These data's were was also found in our study. Increase liver function test is seen in most of our patients and higher percentage of male patients

Naveed S et al[10] studied the experience of liver abscess in tropics The majority of patients in his study had amoebic liver abscesses 73.33%. In our study the percentage of patients with amoebic hepatic abscess was 64.28%.

Rajak CL et al[12], Zerem E et al[13], Singh S et al[14], Jha AK et al[15], Singh O et al[16], Gupta SS et al[30], Bansal A et al[19], Yu SC et al[23] conducted prospective randomized studies comparing PNA with PCD. Rajak et al[12] found that catheter drainage has better terms of success rate than intermittent needle aspiration. Zerem and Hadzic et al[13] researched in 60 patients of pyogenic liver abscess only, and found Percutaneous Catheter Drainage to be more effective. They recommended needle aspiration for simple abscesses of 5 cm or smaller in size. Yu et al[23], included only pyogenic abscesses and showed no significant difference and said that needle aspiration and catheter drainage are effective. Cai YL et al[17] a systematic review and meta-analysis and found that Percutaneous Catheter Drainage to be more efficacious.

But research by Dulku G et al[20] showed needle aspiration to be more effective which is against our study since larger abscess tend to reaccumulate with intermittent needle aspiration. Tan YM et al[21] Open Surgical Drainage to be better because allows for breakdown of loculations and complete drainage of viscid pus and necrotic debris that may provide quicker and more effective drainage with faster resolution of sepsis than Percutaneous Drainage. This difficulty in loculation is overcome by repeated flushing of the catheter. Liu CH et al[34] researched whether Percutaneous hepatic abscess drainage in multiple abscesses or

multiloculated abscesses preclude drainage or affect outcome and found No significant difference in hospital stay was seen between single and multiple abscess groups (P = .373) or between single multiloculated and multiple multiloculated abscess groups (P = .180). There were no major complications or mortality related to the procedure. Similar results as that of Liu CH et al[34] was found in our study and multiloculated abscess can drained usefully with catheter drainage

Bergert H et al[24] compared Therapeutic options in the treatment of pyogenic liver abscess ultrasound-guided percutaneous abscess drainage was done in 41 patients, followed by CT-guided drainage in 13 cases and found no significant prognostic difference for mortality between groups treated with ultrasound-guided percutaneous abscess drainage (7.3 %) and CT-guided drainage (7.7 %) but local complications and drainage failure between ultrasound-guided percutaneous abscess drainage (2.4 %) and CT-guided drainage (15.4 %) showed significant difference, however, better results are found in ultrasound-guided interventions (1/41 vs. 2/13 patients).

Three prospective studies by Bednarek M et al[25], Italiya HB et al[26], Malik SM et al[27] studies showed that percutaneous catheter drainage can be used as first line treatment in management of liver abscess. Malik SM et al[27], Eastiak MF et al[31] studies also included patients with liver abscess

due amebic etiology which shows refractory patients can be successfully treated with this minimally invasive approach.

MA Abusedera et al[42] in his study showed that >50% Size reduction was achieved between 5–17 days with mean of 10.4.our study was even more significant because even >70% size reduction can be achieved between 5-16 days with mean value of 10.16

CONCLUSION

Based on our experience to date and our review of existing literature and we conclude the following to guide the management of hepatic abscess with percutaneous catheter drainage. They are:-

1. Appropriate administration of empiric broad spectrum parenteral antibiotics for pyogenic liver abscess and metronidazole therapy for amoebic liver abscess should be done.

2. Ultrasound and/or CT scan to confirm diagnosis, percutaneous drainage is needed for abscess more than 5cm. with successful outcome.

3. Microbiological analysis of abscess aspirates and blood cultures: antibiotic regimen should be adjusted according to culture results and sensitivities.

4. Percutaneous drain placement is in first line therapy and there is 100% success rate which is equivalent to that of international literatures it also decrease the rate of reduction of abscess size in treatment of liver abscess.

5. Percutaneous drainage can be used in even in multiple and/or large hepatic abscess with septations and in critically ill patients without any major complications with mean reduction time of 10.16 days.

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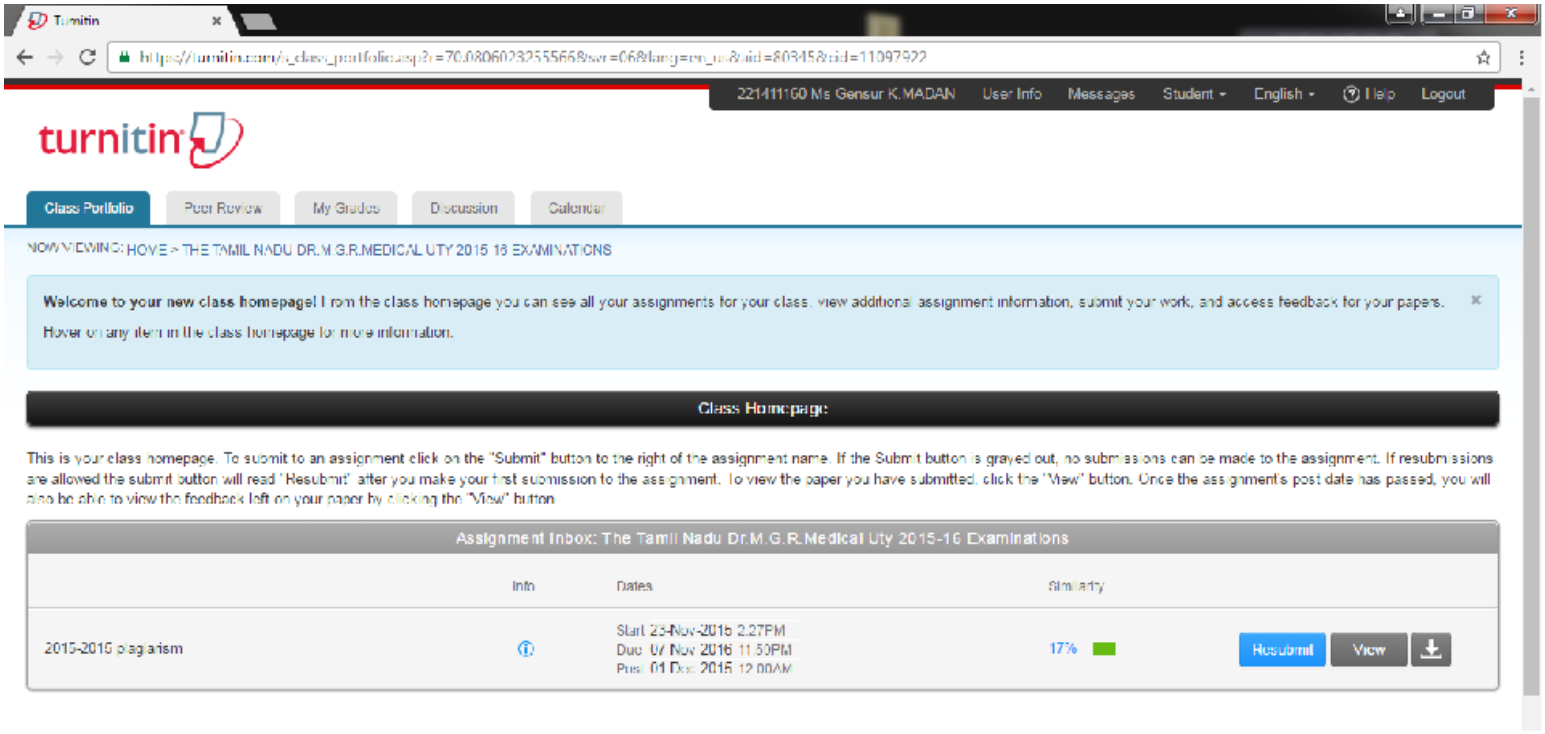
INSTITUTIONAL ETHICS COMMITTEE
GOVT.KILPAUK MEDICAL COLLEGE,
CHENNAI-10
Protocol ID. No. 05/2015 Dt: 22.12.2015
CERTIFICATE OF APPROVAL

The Institutional Ethical Committee of Govt. Kilpauk Medical College, Chennai reviewed and discussed the application for approval "Assessment of outcome of percutaneous drainage in treatment of liver abscess" - For Project Work submitted by Dr.K.Madan, Post Graduate in MS (Gen. Surgery), Govt. Kilpauk medical College, Chennai.

The Proposal is APPROVED.

The Institutional Ethical Committee expects to be informed about the progress of the study any Adverse Drug Reaction Occurring in the Course of the study any change in the protocol and patient information /informed consent and asks to be provided a copy of the final report.

DEAN, 24/12/15
Govt.Kilpauk Medical College,
Chennai – 10.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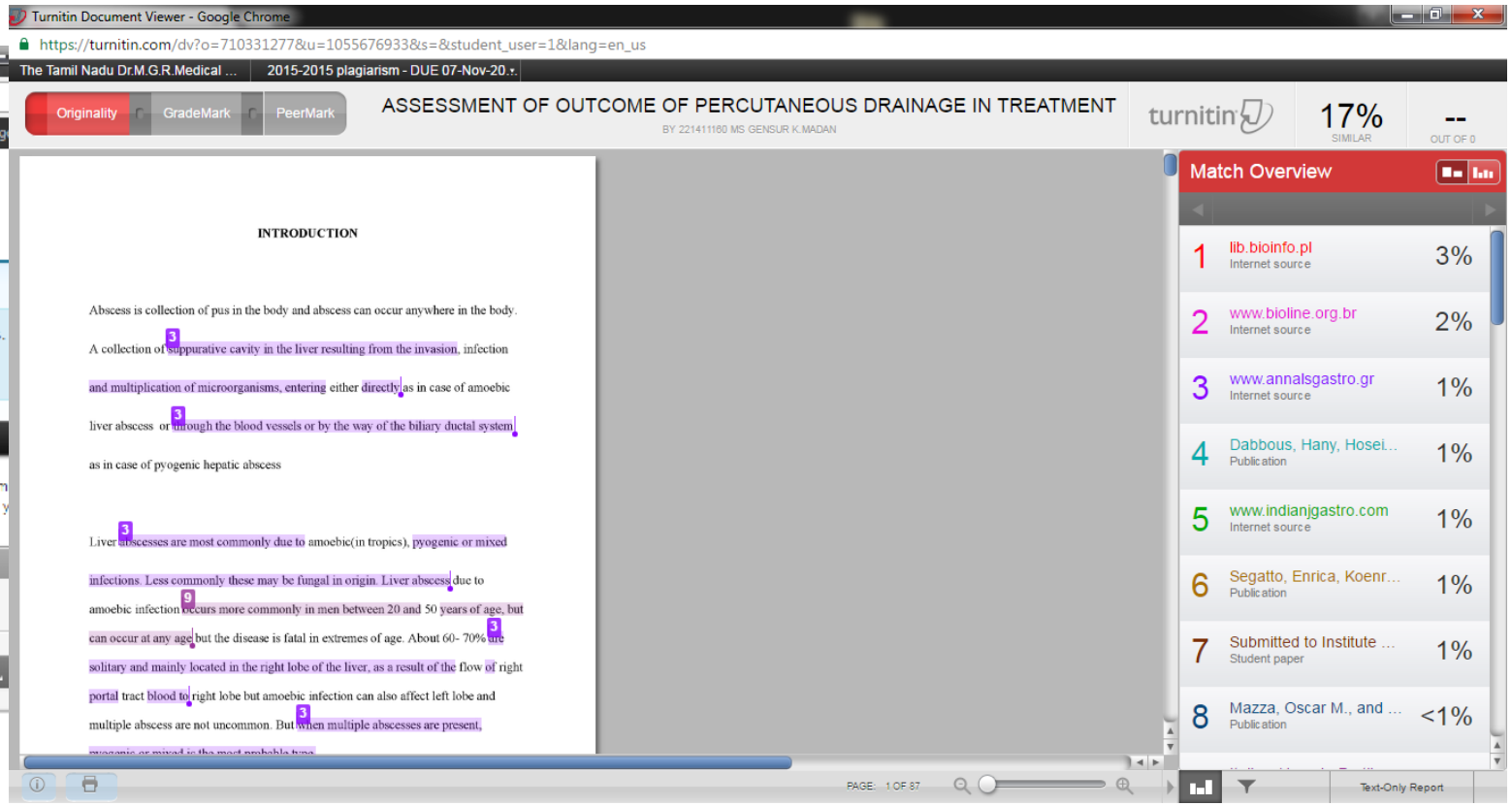
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INTRODUCTION
Abscess is collection of pus in the body and abscess can occur anywhere in the body.
A collection of suppurative cavity in the liver resulting from the invasion, infection
and multiplication of microorganisms, entering either directly as in case of amoebic
liver abscess or through the blood vessels or by the way of the biliary ductal system
as in case of pyogenic hepatic abscess
Liver abscesses are most commonly due to amoebic(in tropics), pyogenic or mixed
infections. Less commonly these may be fungal in origin. Liver abscess due to
amoebic infection occurs more commonly in men between 20 and 50 years of age, but
can occur at any age but the disease is fatal in extremes of age. About 60- 70% are
solitary and mainly located in the right lobe of the liver, as a result of the flow of right
portal tract blood to right lobe but amoebic infection can also affect left lobe and
multiple abscess are not uncommon. But when multiple abscesses are present,
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PAGE: 1 OF 87
Text-Only Report

MASTER CHART

S.NO	IP number	Age	Sex	abdominal pain(visual analong scale)		size of abscess(volume in cc)				disappearance of the abscess(>70%	Time to defervescence of fever(days)	Time until return to work or normal physical
				pre-procedur	post procedure	PP	1st week	2nd week	3rd we			
1	149146	45	M	7	3	240	40			5	4	8
2	245	41	M	6	4	326	100	30		8	2	12
3	641	39	M	7	3	700	360	200	64	14	3	16
4	1025	49	M	6	2	315	110	42		9	5	14
5	975	58	M	7	5	376	60			6	4	10
6	1189	57	M	6	3	275	125	40		8	6	12
7	1472	39	M	7	4	500	260	48		9	2	15
8	1384	48	M	6	6	620	300	120	50	12	4	17
9	1764	27	M	7	3	653	260	48		9	4	17
10	1735	60	M	7	4	523	270	120	30	10	3	13
11	1994	55	F	6	3	432	210	80	20	9	3	12
12	1838	48	M	7	4	390	150	30		9	2	13
13	1807	31	M	8	5	270	90	36		9	3	10
14	2086	39	M	7	3	360	178	60	28	10	4	12
15	2279	44	F	8	2	470	226	100	32	12	2	20
16	2680	52	M	7	2	520	190	70		10	3	15
17	2877	32	M	7	3	380	100	34		8	2	9
18	2991	57	M	8	4	290	96	20		10	3	13
19	2673	50	F	7	3	396	130	40		9	2	15
20	3095	46	M	6	3	360	90	30		8	4	11
21	3041	49	M	7	3	760	410	110	48	8	3	15
22	3562	52	M	8	5	1130	620	310	60	14	6	18

MASTER CHART

23	3992	60	M	6	2	430	260	90	30	10	3	9
24	4773	47	F	7	4	360	160	64		9	3	10
25	4710	53	M	7	4	450	200	140	40	14	2	19
26	5002	58	M	6	3	550	330	180	80	12	3	13
27	5348	43	M	6	3	610	376	180	64	14	2	20
28	5791	46	M	7	5	640	390	210	90	15	3	15
29	5899	59	M	6	4	760	410	260	90	15	4	18
30	6302	39	F	7	3	1060	610	360	##	16	4	21
31	6074	42	M	7	4	370	140			9	3	11
32	6288	44	M	7	4	510	290	142	30	10	3	17
33	6341	50	M	7	4	1050	520	300	##	14	6	19
34	6657	30	M	6	2	470	210	90		9	3	12
35	6890	42	M	6	2	390	190	90	30	12	3	19
36	7074	45	M	7	4	520	180	64		9	3	10
37	7302	53	M	7	3	660	276	90		11	5	14
38	7763	38	M	8	4	730	340	90		9	4	13
39	7509	41	M	8	3	780	380	160	64	10	3	17
40	7850	46	M	8	2	620	210	86		9	3	16
41	8153	55	F	7	4	830	210	80		10	4	16
42	8924	41	M	8	4	410	190	64		11	2	13
43	8577	38	M	7	3	560	286	77		9	4	14
44	9116	43	M	7	2	390	140	48		11	2	15
45	9884	60	M	6	3	370	146	64		9	3	18
46	9417	44	M	7	2	390	134	88		10	2	9
47	9710	47	M	7	2	390	120	48		8	3	11
48	10079	42	F	8	4	580	276	78		9	3	12
49	10654	59	M	9	4	640	265	96		9	3	14

MASTER CHART

50	11376	46	M	7	3	270	130	64		12	2	14
51	11973	34	M	7	3	620	320	90	48	10	3	18
52	12090	55	M	8	3	700	410	146	88	9	2	11
53	12178	38	F	8	3	410	150	78		9	3	12
54	12226	49	M	7	4	320	184	86		11	2	14
55	12436	55	M	7	4	560	334	77		10	3	11
56	12867	51	M	8	3	466	170	90		9	3	16
		46.625		7.017857	3.35714286	470	237.714	102.6	57	10.160714	3.17857143	
		46				520.5714	128.281	74.137	27	9.5		
						390				2.2301797		
						201.5						
						3.598214						
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						4.72E-29						